MEDICAL RESEARCH COMMITTEE

---

# An Inquiry into the Prevalence and Aetiology of Tuberculosis among Industrial Workers, with special reference to Female Munition Workers

*Approved for publication by the Medical Research Committee, 18th October, 1918.*

## Medical Research Committee.

(*National Health Insurance.*)

The Hon. WALDORF ASTOR, M.P. (*Chairman*).
The Right Hon. CHRISTOPHER ADDISON, M.D., M.P.
The VISCOUNT GOSCHEN, C.B.E. (*Treasurer*).
C. J. BOND, C.M.G., F.R.C.S. (Hon. Colonel).
PROFESSOR WILLIAM BULLOCH, M.D., F.R.S.
HENRY HEAD, M.D., F.R.C.P., F.R.S.
PROFESSOR F. G. HOPKINS, D.Sc., F.R.S.
MAJOR-GENERAL SIR WILLIAM LEISHMAN, K.C.M.G., C.B., F.R.S.
PROFESSOR NOËL PATON, M.D., F.R.S.
SIR WALTER M. FLETCHER, K.B.E., M.D., F.R.S.
(*Secretary*).

15 BUCKINGHAM STREET,
STRAND, W.C. 2.

Wt.400/198. 2000. 2/19. O.U.P.

# AN INQUIRY INTO THE PREVALENCE AND AETIOLOGY OF TUBERCULOSIS AMONG INDUSTRIAL WORKERS, WITH SPECIAL REFERENCE TO FEMALE MUNITION WORKERS

BY

M. Gr[illegible]wood, Lister Institute of Preventive Medicine, Capt. R.A.M.C., T., and A. E. Tebb, M.D., Welfare and Health Section, Ministry of Munitions.

## CONTENTS



## Introduction.

The history of the present inquiry is as follows. Towards the end of 1917 we learned that the death-rate from Tuberculosis, which, prior to the war, had been declining, was no longer tending to fall. We of course recognized that changes in the male death-rate shown by civilian records could not, owing to the selection for military duties of able-bodied men, be regarded as of much importance or at all warrant the inference that tuberculous diseases as a whole had become more prevalent. Equally cogent objections could not, however, be urged against the data relative to women, which showed a small but appreciable increase. The war has led to the industrial employment of women upon a scale never hitherto contemplated, and it is arguable that these new conditions of life are responsible for increased incidence of tuberculosis upon the female sex.

This suggestion is to be found in Dr. Stevenson's official review of the Vital Statistics of England and Wales in 1916. He points out that the rise of mortality does not affect women of over 45. He

then remarks that "many thousands of women are now for the first time subjected to the workshop conditions which have probably tended so much to maintain the mortality of males at working ages in recent years. Young women of the most susceptible ages have thus been subjected to risks of infection as well as of pulmonary disease predisposing to tubercle which they would have escaped in following their normal occupations; and both from this cause and from the effect of workshop conditions on women already infected a number of women have probably died who would have survived under peace conditions."[1] It is naturally impossible to put this suggestion to a rigid test, but we have some further evidence which is in favour of its accuracy.

No English rates of occupational mortality among women are available, but the German Imperial Statistical Department published, in 1910,[2] an analysis of the Leipzig experience relative to the period 1887–1901. These data are exiguous enough in comparison with national records, but they cover 288,131 years of life (women) with 1,830 deaths. It was found that the death-rates for males in the various occupations were closely correlated with the known death-rates of the same occupations in England, hence it seemed likely that the rates for women were not wholly inapplicable to those of our country women following similar occupations.

The occupational distribution of the female population as estimated by the Board of Trade for July 1914 and January 1917 is shown in Table 1. Assuming that the Leipzig rates are applicable to these groups, we should anticipate 6,124 deaths from tuberculosis in the 1914 and 7,691 in the 1916 (or, strictly, January 1917) population. To reach the gross deaths we must assume some rate for the large balance of women not industrially employed. The lowest of the occupational rates, viz. 990 per million, has been adopted, the reason being that although the rate for domestic servants, cooks, &c. (970 per million) is even lower. the group here involved includes many women, such as the wives of ill-paid operatives and general labourers, whose mortality experience may be less favourable In this way one reaches an expected total of 22,466 deaths. The actually recorded deaths were 22,214, so that the Leipzig rates applied to the estimated population in groups give us a figure only differing from the truth by 1·1 per cent. With these rates applied to the population as distributed in January 1917, we should expect 23,986 deaths in 1916; the actual figure was 24,131. Here the error is 0·7 per cent. in defect. The computed totals give rates per million of 1,177 and 1,221, while the Registrar-General's computations provide 1,164 and 1,234 per million. The calculation on the Leipzig basis would lead to an increase of 4 per cent. in the death-rate from tuberculosis between 1914 and 1916; actually there has been an increase of about 6 per cent. When it is remembered that not a few of the unoccupied balance may really have been engaged in industrial work although not under conditions which led to their inclusion in the Board of

[1] *Seventy-Ninth Annual Report of the Registrar-General*, p. liv.

[2] *Krankheits- und Sterblichkeitsverhältnisse in der Ortskrankenkasse für Leipzig und Umgegend*, 4 vols., Berlin, 1910.

Trade's statistics, the concordance between the mortality calculated upon the basis of the Leipzig rates and that actually experienced is sufficiently close to lend support to Dr. Stevenson's suggestion that a principal factor is industrial reorganization.

Accepting then, as a working hypothesis, the view that the increased incidence of fatal tuberculosis upon women is a result of industrialization, it follows that a detailed investigation of the mediate factors is an appropriate task for the Medical Research Subsection of the Ministry of Munitions. This report describes the work so far accomplished.

The inquiry has been participated in by the following members of the Subsection. Capt. Greenwood and Misses Thompson and Woods have carried out the statistical analysis. Dr. Tebb has had charge of field inquiries and most of the experimental work. In experiments at the head-quarters laboratory of the Subsection Capt. Greenwood and Dr. Tebb have co-operated.

Valuable assistance and advice have been received from the Director of the Welfare and Health Section, Dr. E. L. Collis, while special thanks are owing to Dr. Leonard Hill, F.R.S., who has kindly permitted both Dr. Tebb and Capt. Greenwood to profit by his personal instruction in the experimental methods utilized.

The report is divided into the following parts:

Part I deals with Occupational Tuberculosis as revealed by the Statistics of Male Operatives, the principal data utilized being from the Registrar-General's decennial supplements including the unpublished data for 1910–12, for the use of which we are indebted to the courtesy of Dr. Stevenson. In this part an attempt has been made to deal with the factor of selection.

Part II is concerned with the occupational morbidity and mortality of women. Owing to lack of trustworthy data this section is incomplete.

Part III examines the regional distribution of mortality in England and Wales during 1911.

Part IV examines the war-time statistics of England and Wales.

Part V is a general account by Dr. Tebb of factory conditions as observed in Birmingham in 1917.

## Part I. Occupational Mortality among Males.

It is not proposed to discuss the general divergences of either mortality or morbidity which differentiate class from class except in so far as they are connected with variations of the incidence of tuberculosis upon different occupations.

In certain instances the objective explanation of such variations has been definitely ascertained. Examples are afforded by the prevalence of maladies directly due to the absorption of lead and by the incidence of pulmonary disease upon the practitioners of certain crafts which lead to the inspiration of special forms of mineral dust. The former instance is a commonplace of medico-

industrial literature, while the latter is the subject of a recent monograph by E. L. Collis,[1] who has proved it to be due to the action of silica particles and to be characterized by an age incidence unlike that observed in other occupational groups or in the population as a whole.

Leaving out these special and well-defined groups, we still observe wide variations of mortality in general, and phthisis mortality in particular, amongst the occupational groups. For instance, the death-rate at ages 25–36 (years 1900–2) from phthisis of males employed in agriculture was 1·10 per 1,000 living, of fishermen 1·40, of shipbuilders 1·53, and of shoemakers 3·27. We have to account for these great differences.

Broadly speaking, we may enumerate the following possible factors.

*Industrial Selection.*[2] Since the type of physique which would suffice for work in a boot factory would be inadequate to the task of a shipwright, we must expect to find stronger and more vigorous men in shipyards than in boot factories. Consequently we should expect to find the death-rate of shoemakers higher than that of shipbuilders even if their occupations in themselves were equally hygienic.

*Industrial Status.* Under this heading we have to record the fact that occupations making equal demands upon the physique (and, perhaps, mental powers) are not equally well remunerated. Professional football players and ploughmen, among the open-air occupations, commercial clerks and higher division civil servants, among sedentary workers, are illustrations. Since the higher the remuneration of the employed person the greater his opportunities of securing an hygienic home environment, it follows that status must powerfully bias the mortality or morbidity rate of any occupation.

*The Industrial Environment itself.*[3] This last cause group is the one we specially desire to unmask. The first group is hardly at all, the second but partially, while the third would be very largely amenable to administrative control if only we knew in what direction such control should be exercised.

To attempt to isolate the effects due to each of these three great groups of causes upon mortality or morbidity as a whole is an undertaking which might daunt any inquirer. The task we are set, although sufficiently formidable, is perhaps less unpromising. We propose to study not mortality as a whole but that fraction of it attributable to one disease only, viz. to tuberculosis. This limitation suggests a plan which should if successful diminish the influence of the first and second cause groups, which do not come within our proposed scope. The plan depends upon the assumption that the death-rate from all causes *except tuberculosis* might be a proper measure both of industrial selection and status.

[1] Milroy Lectures on Industrial Pneumoconiosis, *Public Health*, 1915.

[2] Those who imagine that this factor was invented by 'academic' biometricians in order to display their arithmetical ingenuity should consult Arlidge's classical work, *The Hygiene, Diseases and Mortality of Occupations*, London, 1892.

[3] See Collis, evidence before Royal Commission on Metalliferous Mines, 1914, Cd. 7477, pp 16, 17.

We know that, in the mass, the robust die at a lower rate than the weaklings, that also the rich die at a less rate than the poor. In statistical language, the function which measures physique and the function which measures status are each correlated with the death-rate from all causes. If then we exclude the death-rate due to tubercle, the residue will still be some measure of status *plus* physique unless tuberculosis is the only disease which secures more victims among the poor or weak than among the wealthy or robust. Regarding then the death-rate from other causes as a measure, we shall expect to find correlation between it and the rate from tuberculosis, and can construct a regression equation to predict the tuberculosis rate, having been given the rate from other causes. Should we find that in any particular occupation the tuberculosis rate actually observed is much in excess or defect of that predicted from the non-tuberculous death-rate, we infer that the occupation in question may afford special opportunities for acquiring or offer special barriers against the development of the disease over and above the general factors. This reasoning must be criticized with severity before we accept it. We will take first a purely analytical objection. Should the regression of the tuberculosis death-rate upon the non-tuberculosis death-rate be non-linear, in other words should the relation of the two not be satisfactorily represented by a first degree equation, the latter cannot be expected to afford a good basis of prediction, and the consequent discrepancies between prediction and observation will be of small practical importance. This criticism can be met. We took for testing, the standardized rates for tuberculosis in the occupations studied (these are listed in Table 2) as shown in the returns for 1890–2, 1900–02, 1910–12, providing 178 observations for the two death-rates. For this set the correlation coefficient ($r$) was 0·656 and the correlation ratio 0·692, which tested in the ordinary way shows no sensible departure from linearity. Hence we are to infer that the simple regression equation is probably a suitable basis of prediction.

The next question is whether the death-rate from other causes than tuberculosis is a suitable measure of the combined action of physique and status as apart from industrial environment. We think that it cannot be disputed that the non-tuberculous death-rate is highly correlated with the sum of these factors, is some measure of their combined working, but it is certainly not true that tuberculosis is the only disease that is affected by the factory environment itself. Evidently a great source of error would be present if we included in our survey any occupations, such as pottery work or painting, liable to special *industrial* risk of non-tuberculous disease, and these have been carefully omitted. On the same account we have omitted all occupations having a similarly direct occupational risk of phthisis (such as Silica-working). These omissions simplify the problem, but the objection subsists that the non-tuberculous death-rate is not only a function of the physique and status but is in part a function of the immediate factory environment; there is the further objection that the phthisis death-rate may be *more* closely correlated with physique and status than is the death-rate from other causes. Hence we

must conclude that the sorting out of occupations by the present method can do no more than indicate the occupations peculiarly liable to phthisis or specially immune from it, and does not give a complete statistical account of the matter. Inasmuch, however, as it does pay attention to and allow for the mortality due to other causes, it is at least a step in the right direction.

A more subtle criticism is the following. Infection precedes death, sometimes at a long interval. If the sufferers from phthisis are eliminated from industry at an earlier stage of disease than those affected by some other malady, the correlation of *death*-rates does not exhibit the full stringency of the relation. We have no evidence in favour of or against this hypothesis, beyond what is afforded by an analysis of the data in age groups, consequently we can merely note it and import some additional reserve into the arguments based upon our results. We believe, however, that popular fear of working in association with phthisical subjects is so recent a phenomenon, and even now so local in its influence, that we have no warrant for putting much practical weight upon the objection. We must, however, record the opinion shared by us with all other statisticians that industrial mortality rates are very insecure foundations for elaborate arguments. We are not here alluding to the question of so-called spurious correlation in rates, which is not in our judgment of importance in the present application; we are thinking of the much more serious difficulties associated with (*a*) ambiguities of classification by occupational groups, (*b*) the real numerical strengths of the populations at risks and the consequent weight assignable to particular death-rates. Neither of these serious difficulties can be adequately appraised with the help of the information published or otherwise obtainable.

We shall now review the results due to the employment of our method. The data first to be examined are those for standardized death-rates, (all ages). We have used the Registrar-General's decennial figures for 1890–2, 1900–02, 1910–12, and the special report of the Central Bureau of Statistics in the Hague on the Netherlands experience 1908–11.[1] The first two and the fourth of these collection of data refer to pulmonary tuberculosis; the MS. return for 1910–12 kindly supplied by Dr. Stevenson relates to Tuberculosis in general but, owing to the age limits, will mainly comprise deaths from pulmonary tuberculosis. Tables 2–4 show the occupations studied and the various statistical constants and equations.[2] In Table 4 we give the results of our method of elimination. + against a group means that that group experienced an amount of pulmonary tuberculosis 25 per cent. or more in excess of the figure predicted from its death-rate for other causes. − means similarly that its death-rate from tuberculosis was in defect of the prediction to the extent of 25 per cent. or more.

We note that there are eight groups having an excess at each decennial group of the English statistics, while four of these are

[1] *Bijdragen tot de Statistiek van Nederlanden (nieuwe volgreeks)*, No. 247, 's Gravenhage, 1917.

[2] Since these equations are used as mere interpolation formulae we have not thought it necessary to discuss the probable errors of the various constants.

also in excess in the Dutch data. The four occupations which thus receive the highest possible number of bad marks are Bookbinders, Printers, Tailors, and Cabinet-makers. Hatters, Hosiery-makers, Shoemakers, Hairdressers receive 3 bad marks in the English records, but Hairdressers are actually below the expected figure in the Dutch experience. Woodturners and Coopers have had excess of phthisis in the last two English decennia and in Dutch experience. At the other end of the scale we have six occupational groups showing 25 per cent., or greater, reduction on the predicted value, viz. Farmers, Fishermen, Maltsters, Chemical Manufacturers, Plate-layers, Brick and Tile-makers.

Tables 5 and 6 are concerned with the application of the method to certain age groups in the different occupations. These special groups were chosen on account of the researches made by Brownlee.[1] Brownlee was led by the statistical investigation of the regional data for phthisis mortality provided in the decennial supplements of the Registrar-General to infer that epidemiologically phthisis is a threefold disease. One type specially causes death among the young, a second leads to death in middle life, the mode occurring about the age of 47 years, while a third type affects persons in old age. Brownlee also concluded that the second type was much more sensitive to environment than the first and third, which might perhaps be each due to the same strain of organism. If we accept this hypothesis provisionally it would follow that an excessive mortality in the age group 35–45 is of more significance from the environmental point of view than at an earlier or later age. Of our four black-listed occupations, Bookbinders and Printers show excess at each of the three age groups used. Tailors have no excess between 55 and 65. Cabinet-makers are only excessive at ages 35–45. From these results we seem entitled to infer that the factory conditions of Printers, Bookbinders, and Tailors are specially unfavourable, because, although they have suffered an excessive mortality in the youngest age group and are therefore to that extent select, the toll is still abnormal at ages 35–45. Cabinet-makers, on the other hand, not having been weeded out to the same extent in earlier life might experience an excessive middle-age mortality although the environmental conditions were normal. It must, however, be frankly recognized that this argument is precarious. Those at ages 35–45 are not the survivors of ages 20–25, but contemporaneously existing operatives. To meet this criticism we might deal with the ages of an earlier decennial supplement. But owing to late entrance to a trade this expedient is not entirely satisfactory. We have, however, made an attempt in this direction. The death-rate from phthisis in the age group 35–45 for the occupations was brought into relation with (*a*) the death-rate from all other causes except accidents and suicides for the same age group (decennial supplement 1900–2), and with (*b*) the death-rate from all causes for the age group 25–35 in the decennial return for 1890–2. The regression equation connecting the phthisis death-rate with the two other variables was then calculated. Two

[1] Report to the Medical Research Committee, Special Report Series, No. 18.

occupations used before, viz. numbers 103 and 104, had to be omitted as they were not scheduled in the previous decennium. The resulting equation (Table 7) was not found to give predictions materially different from those based upon contemporaneous mortality alone. As remarked above, the death-rate ten years earlier in an occupation among employees then aged 25–35 is not a satisfactory measure of the mortality experienced by the group of persons from whom the operatives aged 35–45 in this decennium are derived, because of changing occupations. Still, it is *some* measure of their conditions (the correlation between mortality at ages 25–35 in the decennium 1880–90 and that at ages 35–45 in the following decennium is high), and since its use hardly betters the regression equation as a means of prediction, we seem entitled to infer that there really is a large occupational-environmental factor in the causation of phthisis. It would, of course, be practicable as a mere matter of arithmetic to extend this method, taking into consideration yet other variables. But the material objections to which we have above alluded deprive any such extension of so much of its apparent interest as to leave behind hardly sufficient to repay the labour of calculation.

The conclusion to be drawn from the analysis is, we think, that in certain occupations not exposed to a *specific* industrial risk of phthisis, the incidence of this disease is still too heavy to be explained as a by-product of inferior physique independent of the factory environment itself.

## Part II. Industrial Morbidity and Mortality of Women.

The statistical data relative to industrially employed women which have been published are meagre in the extreme. This is in part due to the fact that the employment of women in some industries is a phenomenon of recent times. A more important factor is the limited length of the average industrial life of women consequent upon the fact that in any country a considerable majority of the female inhabitants marry and thereafter cease to figure as industrially employed persons. For these, and other reasons which we need not detail, the English official statisticians—who have provided us with by far the best industrial mortality records for men—have not been able to deal with the statistics of females on similar lines, and such information as we have is derived from continental sources. Tables 9–12 summarize data collected by Prinzing[1] and Koelsch,[2] while Table 8 has been constructed from the information contained in the Leipzig Krankenkasse report of which use was made above. This last table is the most extensive, but, in comparison with a national record, it is obviously imperfect. From our present point of view, the heavy incidence of tuberculosis upon tobacco factory hands, embroiderers, metal workers, and bookbinders is of interest. It will be noted that the Austrian figures (these are death not morbidity rates) also put the tobacco workers in an unfavourable light.

[1] *Handbuch der medizinischen Statistik*, Jena, 1906.

[2] *Krankheit und soziale Lage*, edited by Mosse and Tugendreich, vol. i, Munich, 1912, art. by Koelsch on *Arbeit, bezw. Beruf, in ihrem Einfluss auf Krankheit und Sterblichkeit.*

The occupational classification imposed by the sources and nature of the material is so different from that used in Part I that comparisons are difficult to make. Our black-listed occupations for males were bootmaking, printing, tailoring, and cabinet-making. So far as tailoresses are concerned their morbidity from tuberculosis is not excessive, but in comparison with their sickness from all causes it is somewhat higher than might have been anticipated. In other words, their experience is qualitatively similar to that of males, but quantitatively much more favourable. Neither cabinet-makers nor printers as a whole can be compared with any of the female occupational groups. The boot and shoe factory hands are a small group in the Leipzig records; they contrast sharply with the males, for their tubercle morbidity is definitely below the average and to about the same extent as their morbidity from all causes. This is not an important Leipzig industry. At all ages 11,641 years of male life with 120 cases of tubercle and 1977 years of female life with 11 cases are recorded.

Evidently it would be rash to draw conclusions from such small numbers. It is also clear that comparisons are dangerous owing to the troublesome difficulty of selection, which dogs our steps throughout such inquiries. For instance, the superior position of women in the shoe industries, if any superiority were found on examining large collections of data,[1] might be attributed to selection by many people. Owing to the average woman being less muscular than the average man, a trade which need not recruit the physical *élite* of the men might need the strongest of the women if men and women did the same work. In other words, the female shoe hands might be better physical specimens of womanhood than the male hands of manhood. Similarly, the economically inferior position of women and their practical exclusion up to quite recent times from some of the most highly skilled crafts, leads to the necessity of considering a different scale of values of status.

We are not in a position to determine the validity of these criticisms, but they are of sufficient weight to deprive us of any right to draw definite conclusions from the statistical data provided. The only other investigation which could be carried out on the basis of these figures was to measure the association between tuberculosis and various other diseases. The results are shown in Table 13. It does not seem that any other index than the death or (as here) morbidity rate for all causes other than tuberculosis is superior to such rate for the present inquiry. We had rather hoped that the correlation of tuberculosis rates with cardiac diseases would be high, because in valvular disease of the heart over-exertion is a common and well-known cause of death or incapacity. Hence invalidity or death from this group of diseases might possibly be some measure of the amount of muscular exertion, and would, if highly correlated with the tuberculosis rate, help us to bring the latter into relation with over-strain. The result, however, both from these and other data has not been sufficiently distinct to warrant

[1] No evidence of any sexual distinction was obtained by the Special Investigation Committee of the Medical Research Committee which reported upon the boot and shoe industry in 1915.

practical conclusions, the correlation being non-significant with regard to its probable error.

On the whole, the general statistical data regarding women in industry are very disappointing in scope, and we have therefore had to rely almost entirely upon our own observations. On this account we do not here attempt any general discussion of the subject.

## Part III. The Regional Distribution of Mortality in England and Wales during 1911.

For a study of the regional mortality of tuberculosis in this country it might possibly have been expected that the notification data would have been useful. In truth, however, they are almost valueless. We have spent much time in collating the returns made to the various medical officers of health and published in their annual reports during the last few years and find ourselves in complete accord with the opinion frequently expressed by the medical officers, viz. that the numbers of notified cases do not at present give any real idea of the distribution of the disease, and that the rates are not even useful indices of comparison between district and district. To enforce this we provide in Table 14 a summary of the less evidently incomplete returns, from which it will be perceived that both the fluctuations from year to year in the ratios of deaths to notifications and the wide range of variation from district to district are enough to deprive the notifications of any right to be regarded as measures of true prevalence. Whether notifications of a chronic and not highly infectious disease such as tuberculosis will ever attain the measure of accuracy reached in the zymotic diseases returns (which are themselves, in the view of many good observers, by no means exhaustive) is a matter of doubt; certainly that point has not yet been attained. We shall not, therefore, again refer to notification statistics in general; some notes on the Birmingham figures appear later on. With respect to the problem of regional distribution, Dr. John Brownlee of the Medical Research Committee has recently undertaken a full analysis which was passing through the press at the time this section of our report was being drawn up. Many of his conclusions are of great importance, and some are directly relevant to our inquiry. We have looked at the matter from a different angle and our results are to some extent complementary to certain of his.

It is well known that tuberculosis is more prevalent in towns than in the country and we have no need to encumber our report by citing statistical proofs of the proposition. It is, however, material to learn whether the disadvantage of the towns in this respect is decidedly greater than with regard to mortality from other causes, because the total mortality rate of the rural districts is also less than that of cities. To test the point we considered the distribution of the female population at ages 15–45 and the mortality from pulmonary tuberculosis and from all other causes as ascertained for the year 1911. The correlation between the

mortality from pulmonary tuberculosis and from all other causes was then computed for the metropolitan and country boroughs, for the aggregates of urban districts, and for the aggregates of rural districts. The results are shown in Table 15. It will be seen that the correlations are in descending order of magnitude, passing from rural through urban down to county and metropolitan boroughs. As the departure from linearity, tested by the correlation ratio, is rather greater among the metropolitan and county boroughs than in the rural districts, the difference in stringency of correlation between the two extremes is somewhat exaggerated by a comparison of the coefficients of correlation; it is however considerable. If we now sort out from among the metropolitan and county boroughs those which are the seats of great industries, we retain 33 such centres and the correlation falls still further down to 0·33. For men of the same ages the absolute values of the correlations are smaller but the contrast remains, the value being 0·360 for rural districts and 0·103 for industrial towns.

This regional study then confirms the findings of our industrial analysis, viz. that some factor other than selection by physique is important in leading to the genesis of pulmonary tuberculosis. We must note that the age grouping used is not the one we should have chosen had the work been commenced after a study of Dr. Brownlee's paper; the results are blurred by geographical mixture. Nevertheless in broad outline the statement just made seems to be correct.

We conclude, then, that the incidence of phthisis upon town dwellers is greater than can be accounted for by the general lowering of health associated with urban conditions and is consistent with the view that industrial employment introduces a special factor which makes for the development of tuberculosis, an inference harmonious with those of Part I.

It does not appear to us certain that domestic overcrowding can be a sufficient explanation of the divergences because (*a*) domestic overcrowding is well known to be very gross in many rural districts, and (*b*) the investigations described in the ensuing section do not suggest that domestic overcrowding can, at least statistically, be convicted as the prime offender.

## Part IV. The War-time Statistics in England and Wales.

The data for rendering a statistical account of tuberculosis in war-time are generally meagre. In the first place we have to confine our attention to the female sex; the calling to the colours of a large proportion of able-bodied males has altogether deprived the civilian rates of mortality of any important significance in this matter; those males still within the scope of the Registrar-General's statistics are a physical selection, or rather rejection, of males as a whole. In the second place, when dealing with both males and females we are deprived of the assistance usually rendered by an approximately exact knowledge of the population at ages exposed to risk.

The one datum which remains to us is a knowledge of the deaths at ages and their causes, and what we have now to consider is the value of this information as measuring the incidence of tuberculosis upon a population. The question is: Given a knowledge of the total deaths occurring between certain age limits and the number of such deaths attributed to a single disease for each of a series of groups, how far do fluctuations of the ratio of deaths due to the specified disease to all deaths at that age or, if we prefer it, the ratio of deaths from the specified disease to all other deaths, measure fluctuations of *incidence* of the disease in question. At first sight it appears that such a ratio, which is termed the *proportionate mortality*, is of little value because it is easy to imagine cases in which its value decreased when the real incidence of the disease increased or vice versa. For instance, suppose that the death-rate from phthisis were increasing but not increasing so rapidly as the death-rate from other causes, then the ratio would be decreasing. Suppose again that one were comparing the proportionate mortalities from phthisis in a series of towns, the data being contemporaneous (thus excluding any secular trend). Suppose the actual incidence of phthisis per 1,000 living in the investigated age group were really identical for all towns, then if certain of them suffered heavily from, say, epidemic typhoid, others contained miners from pits which had experienced serious accidents, the proportionate mortalities would differ greatly. As possible sources of error these instances must be admitted; indeed, as a mere matter of simple logic, we could not *expect* to derive as much information from a knowledge of deaths *alone* as from a knowledge of deaths *and* populations. But it would be a gross error to discard a method because it admittedly possesses weak points. Let us look at the other side of the matter. Suppose the rate of mortality from diseases other than those that we were studying were strictly constant; then the ratio of deaths from the special disease to other deaths would be a complete measure of the former's varying incidence. Under such conditions the population at risk would be known, it would be merely the deaths from other diseases multiplied by some constant. Now it is probably true that the death-rates from diseases other than tuberculosis are in certain age groups much less variable than those from phthisis, but the absolute variability is still so high that the hypothetical case is unrealized. The suggestion, however, presents itself that we should directly test the value of a proportionate mortality index by comparing it with the age death-rate in a series of groups where both figures can be computed. This was done by Collis[1] for a series of occupational groups and he found that there was a general correspondence between the proportionate and the true mortality, where one was above its average the other was too. We have probed the matter further. In the first place we used the occupational groups which have appeared so often in our analysis, viz. ages 35–45 of the decennium 1890–1900, and calculated the correlation between the

[1] See Collis's Milroy Lectures on Industrial Pneumoconiosis, p. 26; also Collis's evidence before Royal Commission on Metalliferous Mines, Cd. 7478, pp. 181 and 89.

ratio of deaths from phthisis to deaths from other causes and the death-rate from phthisis. The results are given in Table 17*a*. The correlation is considerable, but as the number of observations was insufficient to construct a correlation table we could not satisfactorily measure the degree of accuracy attained by a linear regression equation in predicting one variable from the other. To this end a series of districts was taken from the decennial report, the criterion being that the mean population at risk should be at least 50,000. In each case the ratio of phthisis deaths to remaining deaths at ages 35–45 and the phthisis death-rate at that age were computed and the two values correlated in the ordinary way. The complete analytical results are shown in Tables 16 and 17 *b*.

These investigations lead to the following results:

(1) There is a substantial correlation between the ratio of phthisis deaths to deaths from other causes within the age group and the actual mortality rate from phthisis at that age group.

(2) The regression of the death-rate upon the proportionate mortality is effectively linear.

(3) Hence from a knowledge of the proportionate phthisis mortality within a group of districts we should reach a fairly accurate prediction of the difference between the average mortality rate for that group of districts and the general average mortality.

(4) But the correlation is not nearly high enough for the prediction of the death-rate *in any individual case* from a knowledge of the proportionate mortality to be within narrow limits on either side of the true value. It is likely to be a very poor approximation.

The practical inference is that much risk of error is incurred when we substitute proportionate mortalities for rates of mortality in our reasonings anent the incidence of tuberculosis. We must go no further than to conclude that when in a group of districts the average ratio shows an increase, then the absolute death-rate for these districts has also increased. This important reservation having been made, we turn to the recent data of phthisis which are expressible merely as ratios.

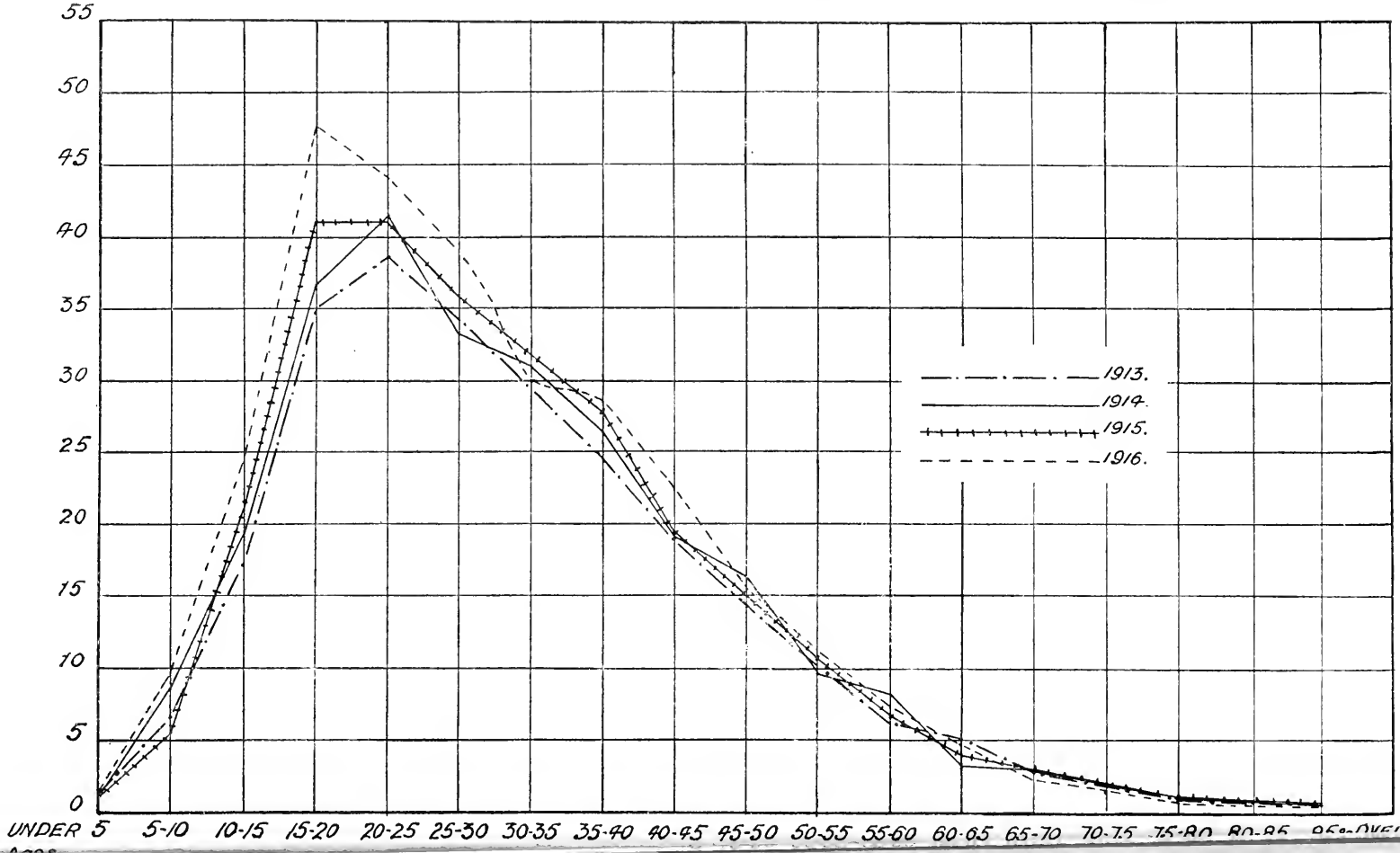
Tables 18 and 19 contain the ratios of phthisis deaths to deaths from other causes among women aged 15–45 in all administrative units for each of the years 1913–16 inclusive. In Table 18 are contained those districts in which the 1916 ratio is greater than the 1913 ratio, in Table 19 those in which it is not greater. For the sake of completeness all areas have been shown, but many of them are so small or thinly populated that the actual ratios are unreliable, one or two deaths more or less influencing the ratio seriously. Confining ourselves to the county and metropolitan boroughs, it appears that 29 showed a lower ratio in 1916 than in 1913, 74 showed an increase.

There is some evidence (Table 20) that the proportion of areas showing an increase of the ratio is larger amongst industrial towns than elsewhere, but the classification is difficult and may even seem capricious while the contrast between the groups formed is not very striking. In order to get to closer quarters with the problem the proportionate mortality (in this case the ordinary proportionate

ADMINISTRATIVE COUNTY OF LONDON

DIAGRAM 1

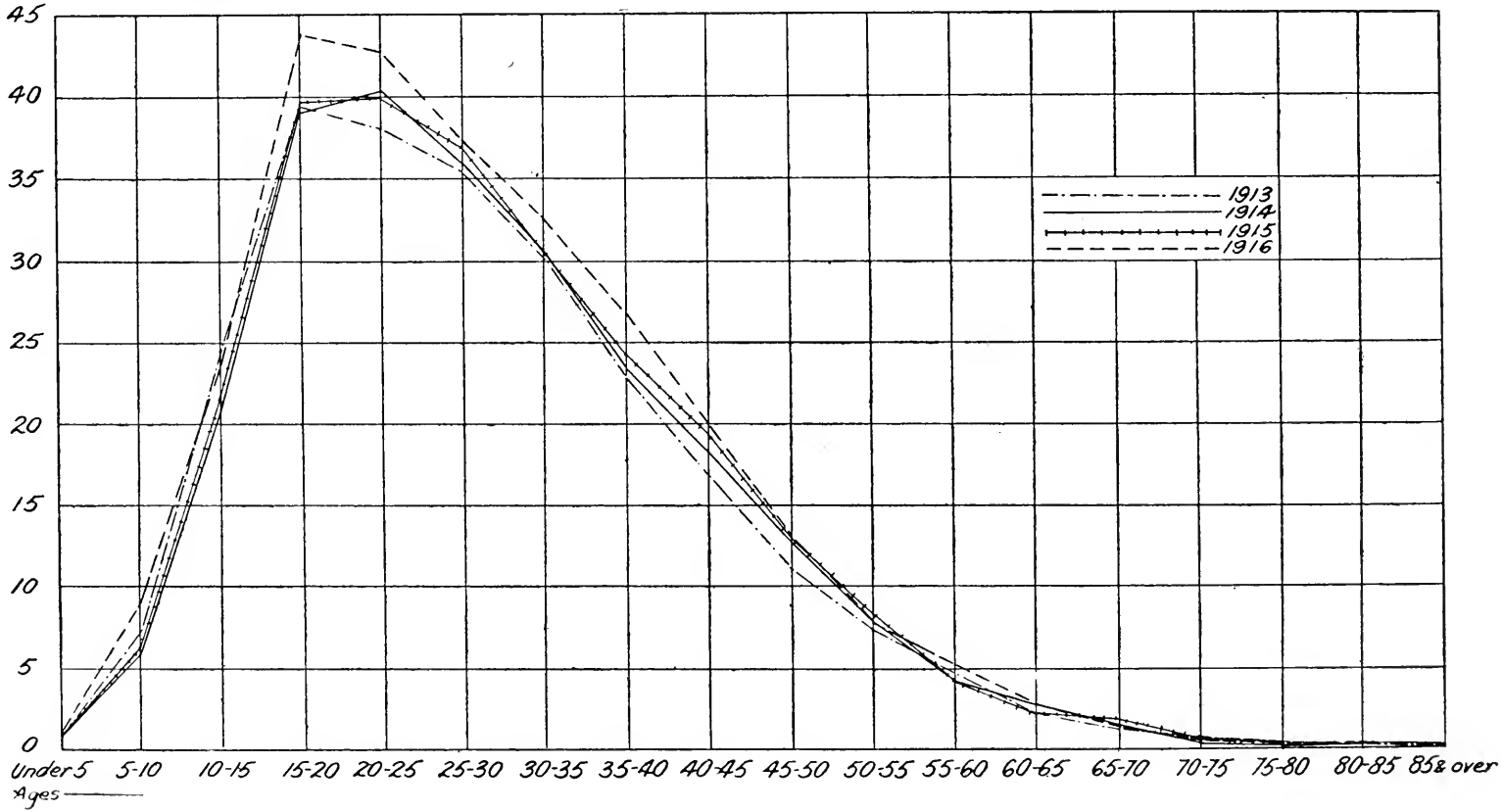
Deaths from Phthisis expressed as Percentages of Deaths from all Causes (Women)



AGGREGATE OF COUNTY BOROUGHS

DIAGRAM 2

Deaths from Phthisis expressed as Percentages of Deaths from all Causes (Women)

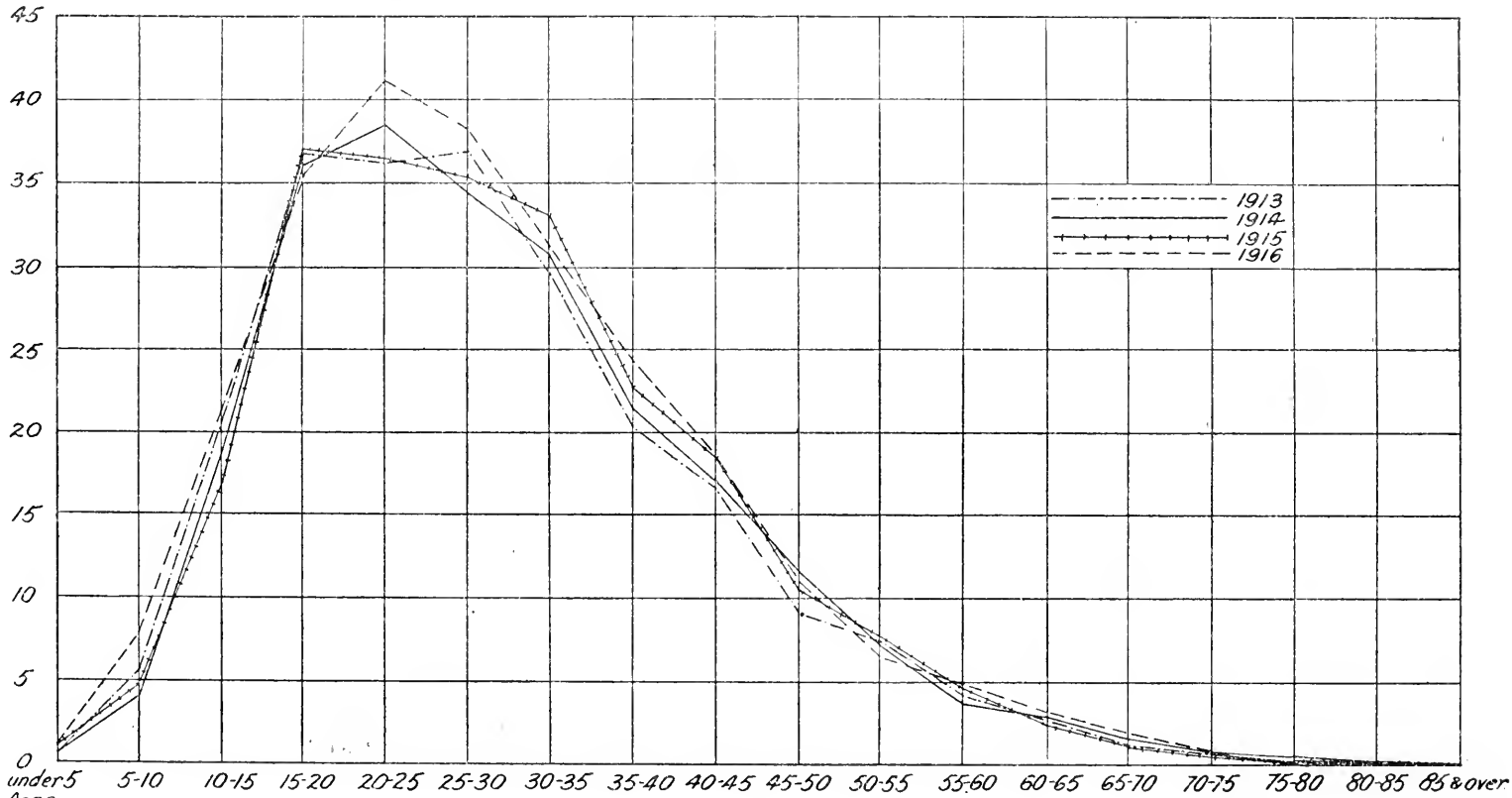



A 5

AGGREGATE OF RURAL DISTRICTS

DIAGRAM 3

Deaths from Phthisis expressed as Percentages of Deaths from all Causes (Women)



mortality, viz. ratio of deaths from phthisis to deaths from all causes at each age) amongst women was plotted in diagrammatic form. Diagrams 1, 2, and 3 show the course of events in the County of London, the County Boroughs, and the aggregate of rural districts for each year from 1913 to 1916 inclusive. It will be noticed that London and the aggregate county boroughs show a considerable and fairly uniform increase of proportionate mortality at ages 15–20 and 20–25, particularly in the earlier quinquennial group, from 1913 onwards. The former peak is not seen in the rural experience. The differences were sufficiently striking to merit special consideration. To that end Dr. Stevenson has kindly supplied the detailed figures from the following towns which we selected, on the advice of Dr. Collis, as representative of different types of community:

(*a*) Cotton towns. Blackburn and Oldham.

(*b*) Metal towns and towns greatly affected by war work. Birmingham, Coventry, Manchester, Newcastle, Sheffield.

(*c*) Industrial towns less directly affected by war conditions. Ipswich, Stoke-on-Trent, Norwich, Worcester, York.

(*d*) Non-industrial towns. Bournemouth, Brighton, Oxford, Great Yarmouth.

Diagrams 4–7 show the position in each of these groups.

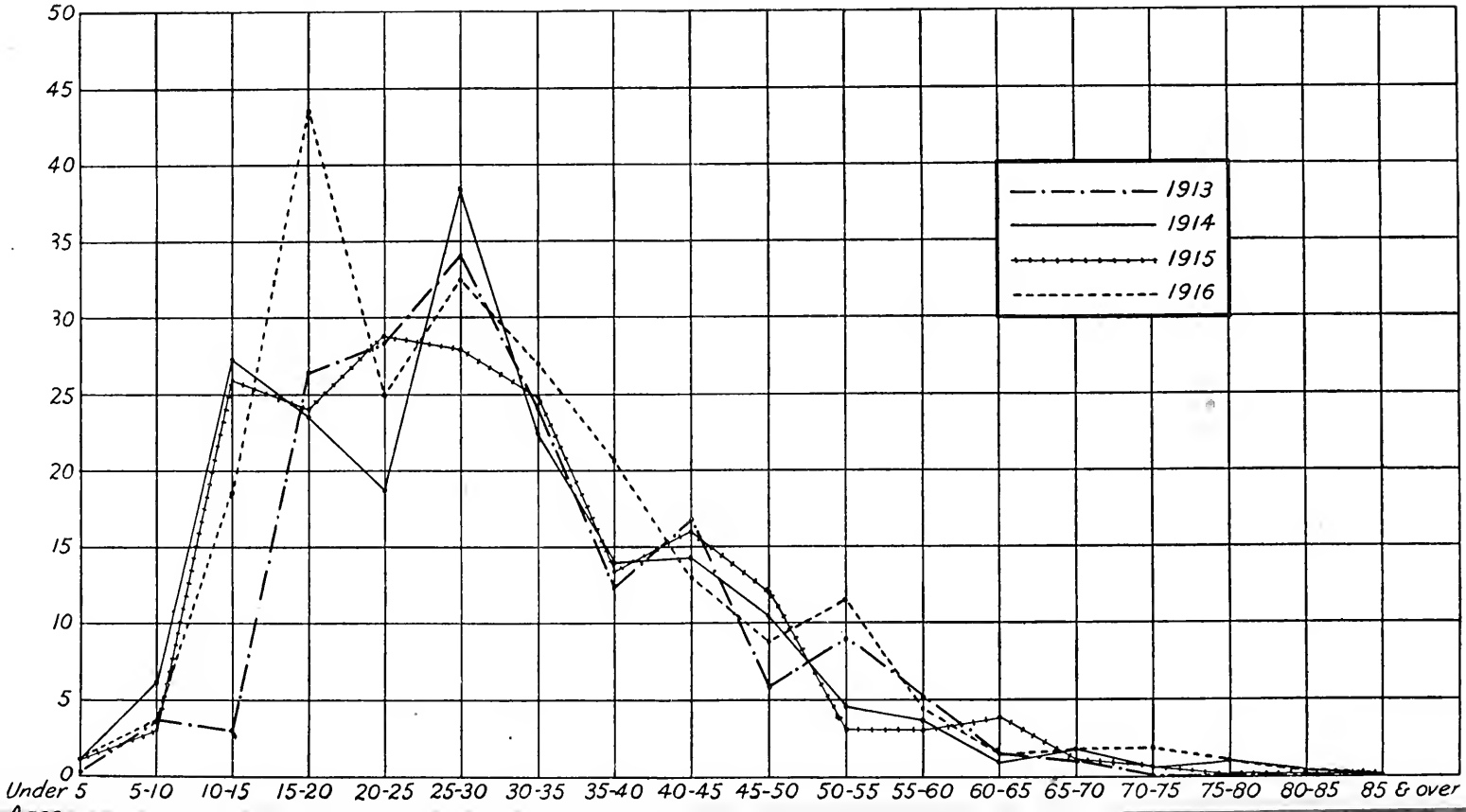
Groups (*a*) and (*b*) agree in the rise at age 15–20. There is a discordance at ages 25–30, where group (*a*) shows a fall. After age 30 the 1916 proportion remains for some time above the level of the other years in both classes. In the group of old-established industries (*c*) the increase at ages 15–20 has not advanced steadily from year to year, but there has been such a steady rise in the next quinquennium, viz. from 20–25.

Group (*d*) contrasts with the industrial towns. There is not an increase but a decrease of the proportionate mortality at ages 15–20, combined with a great elevation at ages 30–35 in the year 1916. Before commenting upon these figures, we must note that statistically they are not equally reliable; in particular the aggregate population of the last group is so much smaller than those of the others that the proportionate figures are *ab initio* suspect owing to errors of sampling and record. Still, making these reservations, it must be said that the curious phenomenon of rising proportionate mortality in the large industrial towns and London at age 15–20 since the war is in need of explanation. The causes of mortality from other diseases at this epoch of life are not numerous nor subject to the considerable fluctuations dependent upon the infantile zymotics. No doubt something can be attributed to the smaller amount of migration to the famous health resorts (which might account for the actual decline of proportionate mortality at this age group in such places as Brighton and Bournemouth), but this can hardly be a sufficient account of the phenomenon when we remember the relative sizes of the populations under notice. The obvious suggestion that the great cities have drawn upon the weaklings of the rural areas (which areas, as seen in Diagram 3, show no increase of proportionate mortality at this quinquennium) seems difficult to avoid. Such a conclusion is compatible with our original surmise

BLACKBURN AND OLDHAM

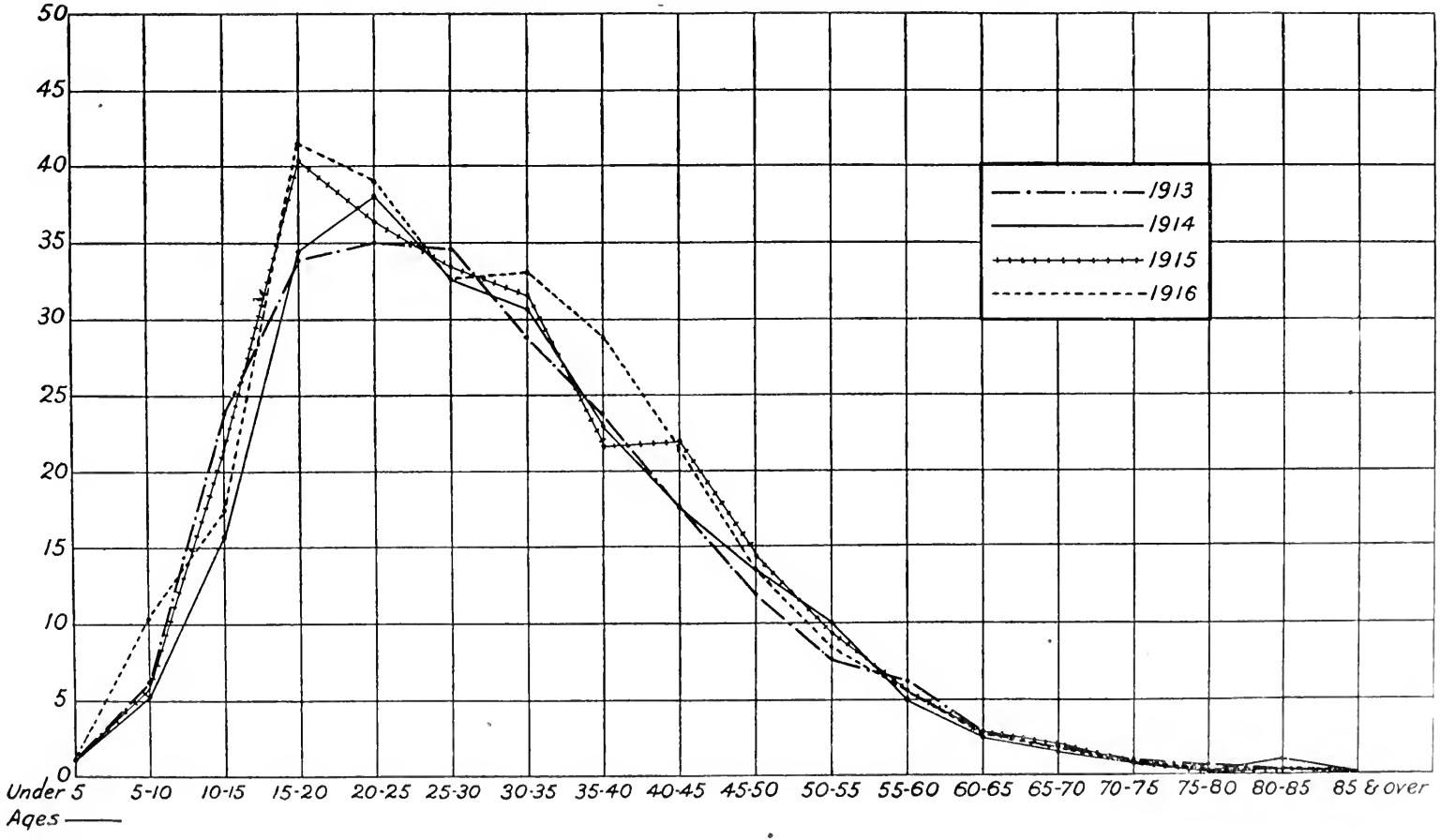
DIAGRAM 4

Deaths from Phthisis expressed as Percentages of Deaths from all Causes (Women)



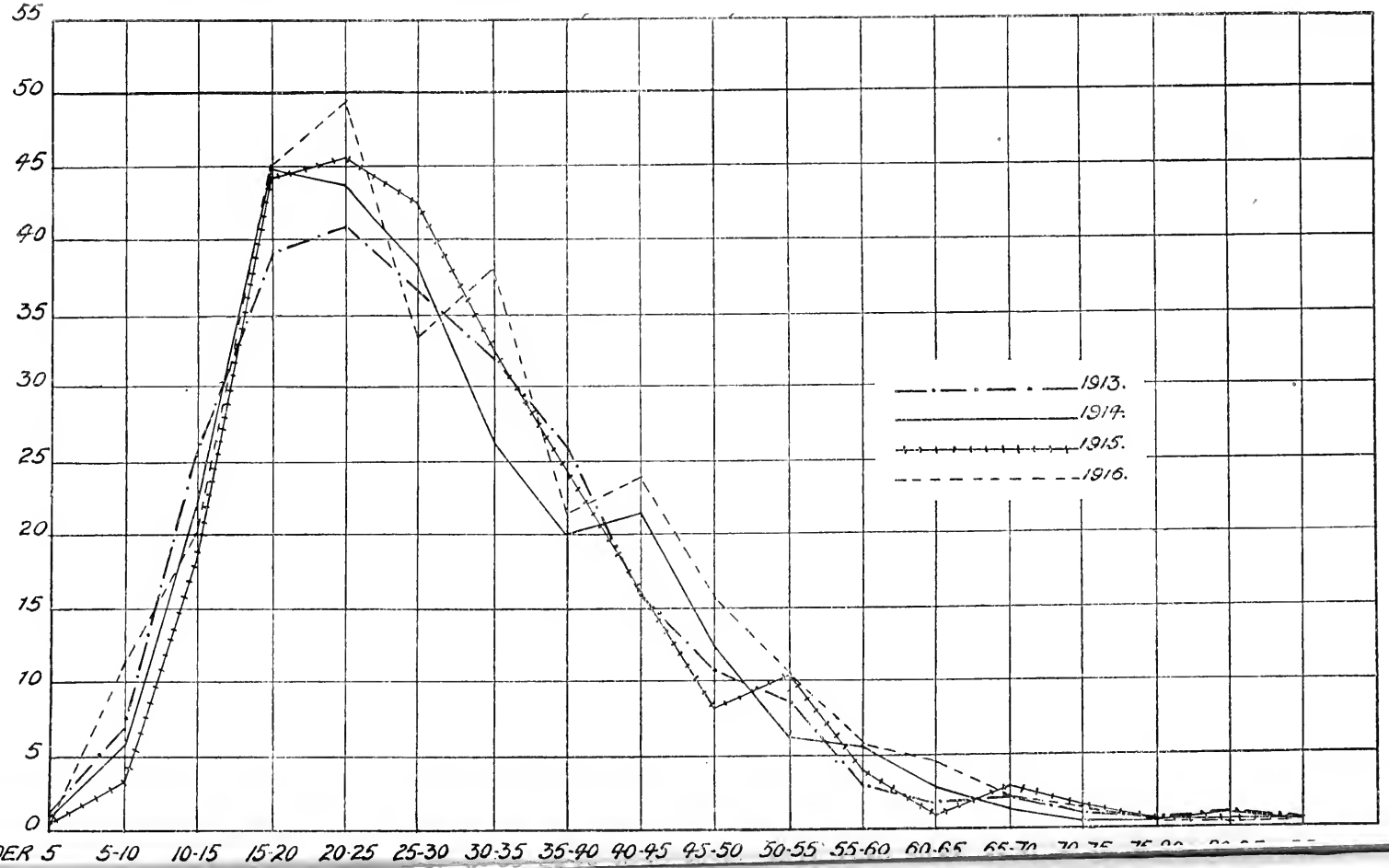
BIRMINGHAM, COVENTRY, MANCHESTER, NEWCASTLE, AND SHEFFIELD

Deaths from Phthisis expressed as Percentages of Deaths from all Causes (Women)



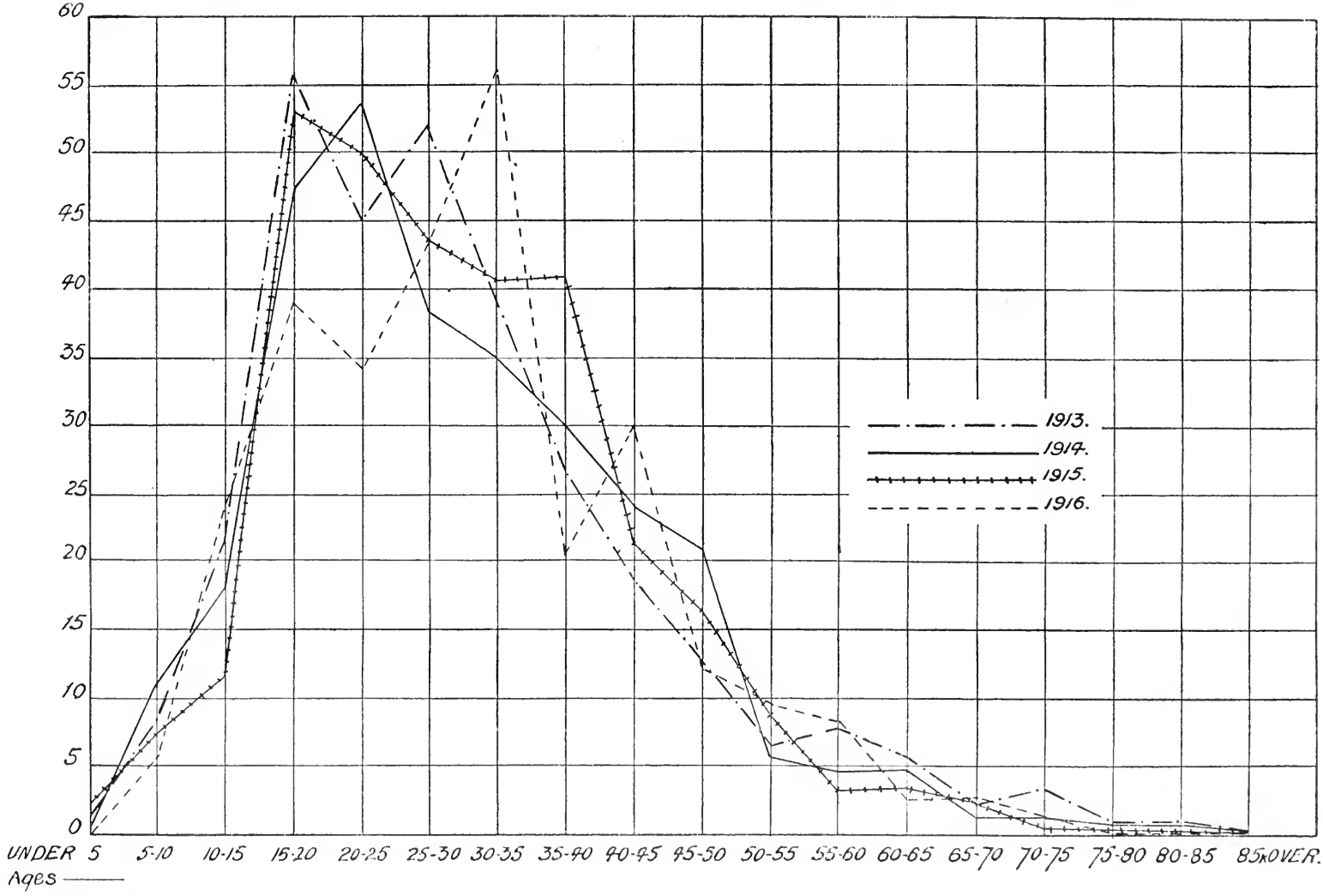
IPSWICH, STOKE-ON-TRENT, NORWICH, WORCESTER, AND YORK DIAGRAM 6

Deaths from Phthisis expressed as Percentages of Deaths from all Causes (Women)



BOURNEMOUTH, BRIGHTON, GREAT OXFORD, AND YARMOUTH DIAGRAM 7

Deaths from Phthisis expressed as Percentages of Deaths from all Causes (Women)



that the war-time increase does depend upon industrialization. We have not, however, been able to provide any other statistical confirmation of this. As mentioned before, we thought that the correlation between mortality from cardiac disease and that from phthisis might be helpful on the assumption that the former would be some index of overstrain. As noted above, however, this surmise is not borne out by analysis of industrial statistics and in any case direct computation showed that the correlation between the two *proportionate* mortalities has not changed since the war. Another suggestion was to deal separately with the various districts, assigning to each an index of its industrial character determined from the 1911 census of occupations. In this way it seemed possible to differentiate machine towns, cotton towns, &c., from other industrial centres. The result, however, of a long and elaborate series of calculations has proved negative. We did indeed arrive at ostensibly large correlation between certain of the variables, but none of these coefficients bore such a ratio to its estimated probable error as to entitle us to use it for drawing practical inferences, and we do not think it justifiable to burden the report by citing the particulars. We have now brought together all the information of a purely statistical character which we have thought to be both fairly reliable and relevant to the issue. We have not dwelt upon the relations between phthisis mortality and domestic overcrowding, not because we doubt the importance of this matter, but because we can cite no data which might be deemed perfectly in point. We did not indeed find any relation whatever between the changes of proportionate mortality and the housing standard as appraised in the 1911 census;[1] but this negative finding proves nothing, since, owing to the redistribution of population due to the war, a 1911 index may have no value when applied to a 1916 population.

In Part V will be found the descriptive account of war-time conditions ostensibly relevant to the issue which formed part of our original programme. This account supplements the statistical data; it was not written originally to form part of a co-operative paper and there is consequently a certain amount of overlapping. As, however, the record of an eyewitness loses vividness when it is altered, we have thought it best to allow it to stand almost as it was written by one of us (A. E. T.) after visiting the area studied.

[1] i. e. overcrowded towns have not deteriorated (from the point of view of phthisis) more than the rest.

## Tables for Parts I—IV.

### Table 1. Women in Industries.

| *Industry.* | *Approximate Number, July, 1914.* | *Approximate Number, Jan., 1917.* | *Tuberculosis Death-rates per 1,000 of Equivalent Class at Leipzig.* | *Expected Deaths, 1914.* | *Expected Deaths, 1916.* |
|---|---|---|---|---|---|
| Metals | 170,000 | 443,000 | 4·04 | 686·8 | 1,789·7 |
| Chemicals | 40,000 | 82,000 | 3·13 | 125·2 | 256·7 |
| Textiles | 863,000 | 883,000 | 2·80 | 2,416·4 | 2,472·4 |
| Clothing | 620,000 | 582,000 | 2·35 | 1,457·0 | 1,367·7 |
| Food | 196,000 | 224,000 | 2·29 | 448·8 | 513·0 |
| Paper and printing | 147,000 | 141,000 | 2·71 | 399·7 | 383·5 |
| Wood | 44,000 | 63,000 | 2·26 | 99·4 | 142·4 |
| Commerce | 496,000 | 773,000 | 0·99 | 491·0 | 765·3 |
| Residue | 16,507,132 | 16,300,000 | 0·99 | 16,342·0 | 16,145·9 |
| Total of Expected Deaths | | | | 22,446·0 | 23,986·0 |
| Total of Observed Deaths | | | | 22,214·0 | 24,131·0 |

## Table 2. Occupations with their Reference Numbers used for Correlation.

| *Ref. No.* | *Occupations.* |
|---|---|
| 15. | Carman, carrier, &c. |
| 16. | Bargeman, lighterman, waterman. |
| 17. | Seaman, &c., merchant service. |
| 18. | Dock labourer, wharf labourer. |
| 20. | Farmer, grazier, farmer's son, &c. |
| 21. | Farm labourer, farm servant. |
| 22. | Gardener, nurseryman, seedsman. |
| 23. | Fisherman. |
| 24. | Maltster. |
| 25. | Brewer. |
| 28 to 38. | All shopkeepers. |
| 39. | Bookbinder. |
| 40. | Printer. |
| 41. | Watch, clock, scientific instrument maker, jeweller, &c. |
| 42. | Saddler, harness maker. |
| 43. | Butcher. |
| 44. | Miller, cereal food manufacture. |
| 45. | Baker, confectioner. |
| 46. | Hatter. |
| 47. | Tailor. |
| 48. | Shoemaker. |
| 49. | Hairdresser. |
| 50. | Tallow, soap, glue, manure manufacture. |
| 51. | Tanner. |
| 52. | Currier, &c. |
| 53. | Engine, machine, boiler-maker, fitter, millwright. |
| 55. | Gunsmith. |
| 56. | Lock, key, gasfittings maker, gas fitter. |
| 57. | Blacksmith, striker. |
| 58. | Nail, anchor, chain, and iron and steel manufacture. |
| 59. | Copper, tin, zinc, lead, brass maker, and worker. |
| 60. | Bricklayer, mason, builder. |
| 61. | Carpenter, joiner. |
| 62. | Slater, tiler. |
| 63. | Paperhanger, plasterer, whitewasher. |
| 64. | Plumber, painter, glazier. |
| 65. | Cabinet maker, &c. |
| 66. | Sawyer. |
| 67. | Wood turner, cooper, &c. |
| 68. | Coach, carriage, railway-coach maker, &c. |
| 69. | Wheelwright. |
| 70. | Shipbuilding. |
| 71. | Chemical manufacture. |
| 72. | Wool, worsted manufacture. |
| 73. | Silk, satin, crape, &c., manufacture. |
| 74. | Cotton manufacture. |
| 75. | Lace manufacture. |
| 76. | Rope, twine, cordmaker. |
| 77. | Textile dyer, bleacher, printer, &c. |
| 78. | Carpet, rug, felt manufacture. |
| 79. | Hosiery manufacture. |
| 80. | Paper manufacture. |
| 81. | Potter, earthenware, &c., manufacture. |
| 82. | Glass manufacture. |
| 90. | Coalheaver. |
| 91. | Gas works service. |
| 92. | Platelayer, railway labourer, navvy, &c. |
| 93. | Brick, plain tile, terra-cotta maker. |
| 103. | Indiarubber worker, waterproof goods maker. |
| 104. | Broom, brush-maker, hair-bristle worker. |

## Table 3. All Ages (Comparative Mortality Figures).

| *Dates.* | *All Causes less Accident, Suicide, and Phthisis.* | | *Phthisis.* | | *Correlation.* | *Regression.* |
|---|---|---|---|---|---|---|
| | *Mean.* | *Standard Deviation.* | *Mean.* | *Standard Deviation.* | | |
| | $x$ | $x$ | $y$ | $y$ | | |
| 1890–2 | 885·2 | 229·8 | 263·79 | 74·32 | + 0·5612 | $y = 0{\cdot}1815\ x + 76{\cdot}13$ |
| 1900–2 | 682·7 | 143·41 | 181·55 | 61·01 | + 0·5890 | $y = 0{\cdot}2506\ x + 10{\cdot}47$ |
| 1910–12 | 617·5 | 144·33 | 153·3 | 54·78 | + 0·6155 | $y = 0{\cdot}2337\ x + 8{\cdot}970$ |
| * Dutch data | 6·608 | 1·540 | 2·123 | 0·9746 | + 0·4670 | $y = 0{\cdot}2956\ x + 0{\cdot}1693$ |

* The Comparative Mortality Figures for the 3 sets of English data show the numbers of deaths that would have occurred in a standard population which provided 1,000 deaths from All Causes among Males aged 25–65 years in England and Wales in 1900–2 had the specific death-rates been applicable to the standard. The Dutch data are death-rates per 1,000 in towns of a standard population based on the age distribution of occupied males aged 18–64. (See *Bijdragen tot de Statistiek van Nederland*, No. 247, p. vi.)

TABLE 4. ALL AGES. Occupations having Phthisis death-rate 25 per cent. above (+) or 25 per cent. below (−) the Expected death-rate.

| *Ref. No.* | *Occupation.* | 1890-2. | 1900-2. | 1910-12. | *Dutch.* |
|---|---|---|---|---|---|
| 16. | Bargeman, lighterman | ... | − | − | + |
| 20. | Farmer, grazier | − | − | − | ... |
| 21. | Farm labourer, farm servant | ... | − | ... | ... |
| 22. | Gardener, nurseryman | ... | − | ... | ... |
| 23. | Fisherman | − | − | − | ... |
| 24. | Maltster | − | − | − | ... |
| 39. | Bookbinder | + | + | + | + |
| 40. | Printer | + | + | + | + |
| 41. | Watch, clock-maker | + | ... | + | ... |
| 42. | Saddler, harness-maker | + | + | ... | ... |
| 43. | Butcher | ... | ... | − | ... |
| 44. | Miller, cereal food-maker | ... | − | − | − |
| 46. | Hatter | + | + | + | ... |
| 47. | Tailor | + | + | + | + |
| 48. | Shoemaker | + | + | + | ... |
| 49. | Hairdresser | + | + | + | − |
| 50. | Tallow, soap manufacture | ... | − | ... | ... |
| 51. | Tanner | − | ... | − | ... |
| 52. | Currier, &c. | ... | ... | + | ... |
| 55. | Gunsmith | + | ... | + | ... |
| 56. | Lock, key, gasfittings-maker | ... | + | ... | ... |
| 65. | Cabinet-maker | + | + | + | + |
| 66. | Sawyer | − | ... | ... | − |
| 67. | Wood-turner, cooper, &c. | ... | + | + | + |
| 69. | Wheelwright | ... | ... | − | ... |
| 70. | Shipbuilding | − | ... | − | − |
| 71. | Chemical manufacture | − | − | − | ... |
| 78. | Carpet, rug manufacture | + | ... | ... | ... |
| 79. | Hosiery manufacture | + | + | + | ... |
| 80. | Paper manufacture | − | ... | ... | ... |
| 81. | Potter, earthenware manufacture | ... | ... | + | ... |
| 92. | Platelayer, railway labourer, navvy | − | − | − | ... |
| 93. | Brick, plain tile, terra-cotta maker | − | − | − | ... |
| 103. | Indiarubber worker, waterproofs | ... | + | ... | ... |
| 104. | Broom, brush-maker, hair-bristle worker | ... | + | + | ... |

TABLE 5. AGE GROUPS, 1900–2 (DEATHS PER 1,000 LIVING).

| *Ages.* | *All Causes less Accident, Suicide, and Phthisis.* | | *Phthisis.* | | *Correlation.* | *Regression.* |
|---|---|---|---|---|---|---|
| | *Mean.* | *Standard Deviation.* | *Mean.* | *Standard Deviation.* | | |
| | $x$ | $x$ | $y$ | $y$ | | |
| 20–25 | 2·244 | 0·6157 | 1·611 | 0·7244 | + 0·3623 | $0·4264\,x + 0·6541$ |
| 35–45 | 6·218 | 1·757 | 2·817 | 1·062 | + 0·4880 | $0·2950\,x + 1·0090$ |
| 55–65 | 28·94 | 5·812 | 2·377 | 0·8064 | + 0·5088 | $0·0706\,x + 0·3306$ |
| 35–45 Dutch data | 4·104 | 1·173 | 1·745 | 1·042 | + 0·3710 | $0·3296\,x + 0·3920$ |

## Table 6. Age Groups, 1900–2.

Occupations having Phthisis death-rate 25 per cent. above (+) or 25 per cent. below (−) the Expected death-rate.

| *Ref. No.* | *Occupations.* | 20–25. | 35–45. | 55–65. | 35–45 (*Dutch*). |
|---|---|---|---|---|---|
| 15. | Carman, carrier | − | ... | ... | ... |
| 16. | Bargemen, lightermen | − | ... | ... | − |
| 18. | Dock labourer | ... | ... | ... | − |
| 20. | Farmer, grazier | − | − | − | − |
| 21. | Farm labourer, farm servant | − | − | − | ... |
| 22. | Gardener, nurseryman | − | − | ... | ... |
| 23. | Fisherman | − | − | ... | ... |
| 24. | Maltster | ... | − | ... | ... |
| 25. | Brewer | − | ... | ... | ... |
| 28. | Stationery manufacture | ... | ... | ... | + |
| 39. | Bookbinder | + | + | + | + |
| 40. | Printer | + | + | + | + |
| 41. | Watchmaker, jeweller | ... | ... | + | ... |
| 42. | Saddler and harness maker | + | ... | ... | ... |
| 43. | Butcher | − | ... | − | ... |
| 44. | Miller | − | ... | ... | − |
| 45. | Baker and confectioner | ... | ... | ... | − |
| 46. | Hatter | + | + | ... | ... |
| 47. | Tailor | + | + | ... | + |
| 48. | Shoemaker | + | + | ... | ... |
| 49. | Hairdresser | + | + | ... | ... |
| 51. | Tanner | ... | − | ... | ... |
| 52. | Currier | + | + | ... | ... |
| 55. | Gunsmith | − | ... | + | ... |
| 56. | Lock-maker, gasfitter | − | ... | + | ... |
| 57. | Blacksmith, striker | − | ... | ... | ... |
| 58. | Nail, anchor, chain-maker | − | ... | ... | ... |
| 60. | Bricklayer, mason | − | ... | + | ... |
| 61. | Carpenter and joiner | ... | ... | ... | + |
| 62. | Slater and tilers | − | ... | − | ... |
| 63. | Paperhangers, plasterer | − | + | + | + |
| 65. | Cabinet-maker | ... | + | ... | + |
| 66. | Sawyer | ... | − | ... | − |
| 67. | Wood-turners and coopers | ... | ... | ... | + |
| 68. | Coach, carriage-maker | − | ... | − | ... |
| 70. | Shipbuilding | ... | ... | − | − |
| 71. | Chemical manufacture | − | − | − | ... |
| 72. | Wool, worsted manufacture | + | ... | ... | ... |
| 73. | Silk, satin, crape manufacture | + | − | + | ... |
| 76. | Rope, twine, cord-maker | ... | ... | + | ... |
| 77. | Textile dyer, bleacher | ... | ... | − | ... |
| 78. | Carpet, rug manufacture | + | ... | ... | ... |
| 79. | Hosiery manufacture | ... | ... | + | ... |
| 82. | Glass manufacture | ... | + | ... | + |
| 90. | Coalheaver | ... | ... | − | − |
| 91. | Gas-works service | ... | − | ... | ... |
| 92. | Platelayer, navvy | ... | − | ... | ... |
| 93. | Brick and tile maker | − | − | − | − |
| 103. | Indiarubber worker | − | ... | ... | ... |
| 104. | Brush-maker, hair-bristle worker | + | + | ... | ... |

## Table 7. Correlations. Regression. Age Groups.

| *All Causes*, 1890-2. *Age Group*, 25-35 ($a$). | *All Causes less Accident, Suicide, and Phthisis*, 1900-2. 35-45 ($x$). | *Phthisis*, 1900-2. 35-45 ($y$). |
|---|---|---|
| *Mean* $a$ = 7·701. | *Mean* $x$ = 6·201. | *Mean* $y$ = 2·777. |
| Standard Deviations: | $\sigma_{y.x\,a}$ = 0·842. | $\sigma_{x.ay}$ = 0·728. | $\sigma_{a.xy}$ = 0·970. |
| Correlations: | $r_{yx.a}$ = 0·096. | $r_{ya.x}$ = 0·239. | $r_{xa.y}$ = 0·838. |
| Regression: | $y = 0{\cdot}106\,x + 0{\cdot}198\,a + 0{\cdot}589.$ | | |

## Table 8. Leipzig Ortskrankenkasse Experience.

### Special Trades employing at least 1,000 Women between the ages 15–35.

| *Trade.* | *Years of Life at Risk.* | *All Causes.* | *In Terms of Average.*[1] | *Respiratory Diseases.* | *In Terms of Average.*[1] | *Accidents.* | *In Terms of Average.*[1] | *Tubercle Case Rate per 1,000.* | *In Terms of Average.* | *In Terms of Corresponding Male Rate.* | *Heart Diseases Case Rate.* | *In Terms of Average.*[1] | *Nervous Diseases Case Rate.* | *In Terms of Average.* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Domestic general servants | 17,940 | 249·7 | 58 | 20·1 | 54 | 3·3 | 36 | 2·2 | 33 | ... | 4·7 | 74 | 6·2 | 49 |
| Cooks | 7,067 | 306·4 | 71 | 30·2 | 81 | 4·5 | 50 | 1·7 | 26 | ... | 4·8 | 76 | 9·1 | 72 |
| Waitresses | 4,060 | 295·8 | 69 | 23·3 | 62 | 0·5 | 6 | 3·7 | 56 | 70 | 2·0 | 31 | 9·9 | 79 |
| Washerwomen and ironers | 3,141 | 360·4 | 84 | 26·9 | 72 | 6·1 | 67 | 1·9 | 29 | ... | 2·6 | 41 | 12·4 | 99 |
| Shop assistants | 21,038 | 304·2 | 71 | 27·5 | 74 | 0·9 | 10 | 2·8 | 42 | 39 | 6·8 | 107 | 11·7 | 93 |
| Office assistants (typists, clerks, &c.) | 11,204 | 232·3 | 54 | 28·4 | 76 | 0·6 | 7 | 3·7 | 56 | 49 | 4·6 | 72 | 13·8 | 110 |
| Tailoresses and seamstresses (general) | 19,852 | 360·9 | 84 | 40·7 | 109 | 2·5 | 28 | 6·5 | 98 | 53 | 6·3 | 99 | 12·6 | 100 |
| Tailoresses and seamstresses (private) | 14,332 | 322·3 | 75 | 36·1 | 97 | 2·2 | 24 | 6·1 | 92 | 61 | 7·0 | 110 | 10·9 | 87 |
| Millinery makers | 6,799 | 320·6 | 74 | 26·8 | 72 | 1·3 | 14 | 7·1 | 107 | ... | 6·2 | 98 | 10·9 | 87 |
| Bookbinders | 20,742 | 486·7 | 113 | 55·4 | 148 | 13·0 | 143 | 9·5 | 143 | 93 | 7·5 | 118 | 16·3 | 130 |
| Other manufacturing book trade hands | 13,191 | 462·2 | 107 | 26·9 | 72 | 17·7 | 195 | 8·0 | 120 | 90 | 6·8 | 107 | 12·9 | 103 |
| Auxiliary book trade hands | 6,634 | 484·3 | 113 | 29·8 | 80 | 15·2 | 167 | 7·5 | 113 | 51 | 7·5 | 118 | 13·4 | 107 |
| Coloured and luxus paper factories | 7,121 | 524·7 | 122 | 26·5 | 71 | 13·1 | 144 | 5·2 | 78 | 116 | 6·5 | 102 | 13·2 | 105 |
| Musical instrument factories | 2,315 | 436·3 | 101 | 31·5 | 84 | 11·2 | 123 | 6·5 | 98 | 66 | 7·3 | 115 | 9·9 | 79 |
| Metal factories | 4,166 | 563·6 | 131 | 26·3 | 70 | 44·2 | 486 | 10·1 | 152 | 131 | 4·3 | 68 | 17·3 | 137 |
| Mineral water, vinegar, jam, &c., factories | 3,204 | 529·7 | 123 | 25·2 | 67 | 14·7 | 162 | 8·4 | 127 | 162 | 12·5 | 197 | 10·3 | 82 |
| Weavers | 3,113 | 529·4 | 123 | 26·5 | 71 | 13·5 | 149 | 8·4 | 127 | ... | 6·4 | 101 | 11·6 | 92 |
| Embroiderers | 3,523 | 372·7 | 87 | 33·4 | 89 | 1·4 | 15 | 12·8 | 193 | ... | 6·2 | 98 | 13·6 | 108 |
| Boot and shoe factories | 1,731 | 390·9 | 91 | 43·3 | 116 | 6·5 | 72 | 5·8 | 87 | 57 | 5·8 | 91 | 6·9 | 55 |
| Furriers | 1,406 | 535·6 | 124 | 88·9 | 238 | 7·8 | 86 | 6·4 | 96 | 81 | 5·7 | 90 | 10·0 | 79 |
| Toy factories | 1,888 | 556·7 | 129 | 53·5 | 143 | 9·0 | 99 | 8·5 | 128 | 91 | 9·5 | 150 | 13·2 | 105 |
| Measuring instrument factories | 2,073 | 518·6 | 120 | 56·0 | 150 | 17·4 | 191 | 6·3 | 95 | 34 | 4·3 | 68 | 7·7 | 61 |
| Rubber factories | 2,097 | 606·1 | 141 | 59·6 | 159 | 6·2 | 68 | 6·7 | 101 | 64 | 7·2 | 113 | 32·4 | 258 |
| Tobacco and cigar factories | 1,292 | 451·2 | 105 | 57·3 | 153 | 4·6 | 51 | 14·7 | 221 | 84 | 3·9 | 61 | 11·6 | 92 |
| Type foundries | 1,270 | 466·9 | 108 | 39·4 | 105 | 5·5 | 61 | 6·3 | 95 | 66 | 7·9 | 124 | 13·4 | 107 |
| Photographic processes | 2,078 | 356·1 | 83 | 44·8 | 120 | 1·0 | 11 | 4·8 | 72 | 126 | 9·6 | 151 | 12·5 | 99 |
| Wool-combers and spinners | 16,119 | 598·1 | 139 | 25·4 | 68 | 21·5 | 237 | 7·6 | 114 | 107 | 7·6 | 120 | 16·1 | 128 |

[1] Unweighted average of the 27 groups.

## Table 9. Bavarian Phthisis Mortality, 1908.

(Koelsch in Mosse and Tugendreich, I. 182.)

| *Occupation.* | *Age Classes.* 15-19. | 20-29. | 30-39 | 40-49. | 50-59. | 60-69. | *All Ages.* | *Population.* | *Per 1,000.* |
|---|---|---|---|---|---|---|---|---|---|
| *Women.* | | | | | | | | | |
| Peasants | 126 | 290 | 304 | 219 | 167 | 134 | 1,240 | 867,902 | 1·43 |
| Flower-makers | ... | 3 | 3 | ... | ... | ... | 6 | 901 | 6·66 |
| Brush-makers | 1 | 5 | 1 | ... | ... | ... | 7 | 2,904 | 2·41 |
| Deaconesses | ... | 1 | 4 | 1 | ... | 1 | 7 | 921 | 7·60 |
| Waitresses | 2 | 12 | 3 | ... | 1 | ... | 18 | 11,246 | 1·60 |
| Nuns | 2 | 41 | 43 | 9 | 2 | 3 | 100 | 13,564 | 7·37 |
| Teachers | 3 | 10 | 3 | ... | ... | 6 | 18 | 11,632 | 1·55 |
| Domestic servants | 72 | 179 | 72 | 27 | 19 | 10 | 379 | 27,350 | 13·86 |
| Seamstresses | 19 | 81 | 39 | 9 | 9 | 5 | 163 | 25,157 | 6·48 |
| Day workers | 1 | 10 | 18 | 25 | 13 | 13 | 80 | 2,292 | 34·90 |
| Sales-women | 11 | 22 | 5 | 3 | ... | ... | 41 | 16,892 | 2·43 |
| Washerwomen, ironers | 1 | 8 | 2 | 6 | 3 | 1 | 21 | 9,244 | 2·27 |
| Tobacco workers | ... | 7 | 2 | ... | ... | ... | 9 | 6,508 | 1·38 |
| Other occupations | 539 | 1,511 | 1,390 | 808 | 590 | 470 | 5,308 | 1,305,584 | 4·07 |

TABLE 10. SCHULER AND BURCKHARDT'S SWISS (1880–4) EXPERIENCE.* DISTRIBUTION OF CAUSES OF SICKNESS PER 100 CASES.

| *Diseases.* | *Cotton.* | | | *Embroiderers.* | *Silk Weavers.* | *All Textile Workers.* |
|---|---|---|---|---|---|---|
| | *Spinners.* | *Weavers.* | *Pressers.* | | | |
| Of the digestive organs | 27·1 | 36·6 | 28·9 | 35·0 | 29·1 | 32·7 |
| Respiratory | 18·9 | 18·3 | 17·4 | 15·8 | 18·8 | 18·3 |
| Of circulation | 1·2 | 1·7 | 0·4 | 0·5 | 1·3 | 1·3 |
| Of locomotion | 9·5 | 6·2 | 6·8 | 6·7 | 8·2 | 7·4 |
| Of the nervous system | 2·7 | 2·1 | 1·7 | 0·9 | 0·7 | 1·9 |
| Of the skin | 6·2 | 4·1 | 10·6 | 12·5 | 4·5 | 5·7 |
| Of the eyes | 2·7 | 3·6 | 2·9 | 5·1 | 2·8 | 3·3 |
| Urinary and sexual | 3·2 | 5·6 | 9·3 | 3·4 | 4·8 | 4·8 |
| Contagious | 3·9 | 3·5 | 2·5 | 4·3 | 7·1 | 4·3 |
| Constitutional | 15·0 | 13·1 | 13·2 | 12·1 | 17·1 | 14·1 |
| Injuries | 5·3 | 1·9 | 3·8 | 0·8 | 2·2 | 2·7 |
| Miscellaneous | 4·3 | 3·3 | 2·5 | 2·9 | 3·4 | 3·5 |

* See Prinzing, *Handbuch d. mediz. Statistik*, p. 139.

TABLE 11. FRANKFURT, 1896 (INCIDENCE PER 100 FEMALE MEMBERS). (PRINZING.)

| *Diseases.* | *Servants.* | | *Waitresses.* | | *Shop Assistants.* | | *Seamstresses.* | | *All.* | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Able to work.* | *Unable to work.* | *Able to work.* | *Unable to work.* | *Able to work.* | *Unable to work.* | *Able to work.* | *Unable to work.* | *Able to work.* | *Unable to work.* |
| Infections | 1·5 | 3·3 | 1·5 | 3·6 | 1·5 | 3·9 | 1·0 | 4·4 | 1·6 | 4·0 |
| Tonsilitis | 2·2 | 1·9 | 3·2 | 2·0 | 5·1 | 3·7 | 4·1 | 3·2 | 3·0 | 3·0 |
| Anaemia and Chlorosis | 9·6 | 1·9 | 9·2 | 1·7 | 23·9 | 6·2 | 17·1 | 6·2 | 14·6 | 5·0 |
| Syphilis | 0·3 | 0·5 | ... | 0·2 | 0·1 | ... | 0·5 | 0·3 | 0·4 | 0·2 |
| Nervous | 2·3 | 0·3 | 2·3 | 0·3 | 7·3 | 1·7 | 4·4 | 1·8 | 4·5 | 1·2 |
| Of the digestive organs | 8·3 | 4·1 | 12·6 | 4·3 | 10·2 | 5·5 | 9·8 | 6·7 | 9·5 | 6·1 |
| Circulatory | 0·9 | 0·5 | 2·3 | 1·5 | 2·0 | 0·7 | 0·9 | 0·8 | 1·2 | 0·8 |
| Sexual | 2·1 | 1·0 | 3·7 | 2·2 | 3·7 | 1·4 | 2·6 | 1·0 | 3·0 | 1·6 |
| Respiratory | 6·0 | 3·3 | 5·5 | 4·4 | 10·7 | 5·8 | 8·2 | 7·0 | 7·8 | 5·8 |
| Locomotion | 4·7 | 4·1 | 7·9 | 2·5 | 5·0 | 2·5 | 4·7 | 4·0 | 4·9 | 3·9 |
| Skin | 6·1 | 4·1 | 7·9 | 4·1 | 11·3 | 3·0 | 6·7 | 2·2 | 7·5 | 3·4 |
| Eyes | 3·8 | 0·6 | 2·0 | 0·5 | 8·0 | 0·6 | 6·5 | 0·6 | 5·8 | 0·6 |
| Accidents | 3·2 | 2·3 | 2·3 | 2·5 | 2·8 | 1·0 | 1·6 | 1·2 | 2·4 | 1·9 |
| Other diseases | 7·6 | 1·7 | 5·0 | 1·5 | 18·7 | 1·9 | 12·7 | 1·4 | 12·8 | 1·9 |
| All diseases | 58·6 | 29·6 | 65·1 | 39·3 | 110·3 | 37·9 | 80·8 | 40·8 | 79·0 | 39·4 |

TABLE 12. AUSTRIAN OCCUPATIONAL MORTALITY, 1891–5, PER 1,000 LIVING.

(Cited from Mosse and Tugendreich, p. 200.)

| | 15–20. | 20–30. | 30–40. | 40–50. | 50–60. | *Standard.* |
|---|---|---|---|---|---|---|
| All male operatives | 5·2 | 6·6 | 9·0 | 14·2 | 23·1 | 100 |
| All female operatives | 8·1 | 9·2 | 10·0 | 12·4 | 17·1 | 109 |
| Tailoresses | 5·9 | 5·3 | 7·8 | (12·5) | (17·1) | (86) |
| Glove-makers | 8·9 | 10·1 | 8·2 | 17·2 | 31·7 | 132 |
| Textile workers | 9·8 | 11·3 | 10·9 | 12·2 | 16·4 | 121 |
| Tobacco workers | 11·0 | 13·3 | 12·7 | 11·4 | 15·5 | 133 |
| Brick and cement workers | 9·7 | 6·4 | 6·5 | 10·2 | 10·6 | 84 |
| Clay and porcelain workers | 7·7 | 10·3 | 10·8 | 15·7 | 24·2 | 126 |
| Wood workers | 8·2 | 8·6 | 11·2 | 14·7 | 32·4 | 127 |
| Clothing factories | 8·6 | 11·8 | 10·4 | 6·3 | 11·3 | 105 |

TABLE 13. CORRELATIONS OF THE TUBERCULOSIS RATES WITH OTHER RATES.

*Leipzig* (*Women*) *Ages* 15–34 (*Case Rates*).

| | |
|---|---|
| Tubercle with all causes less tubercle and cardiac diseases | $r = 0{\cdot}491 \pm 0{\cdot}10$ |
| ,, ,, cardiac diseases | $r = 0{\cdot}214 \pm 0{\cdot}12$ |
| ,, ,, nervous diseases | $r = 0{\cdot}231 \pm 0{\cdot}12$ |

*English* (*Men*) *Ages* 15–34 (*Death Rates*).

| | |
|---|---|
| Tubercle with cardiac diseases (48 occupational groups) | $r = 0{\cdot}27 \pm 0{\cdot}09$ |

TABLE 14. PERCENTAGE OF DEATHS FROM PHTHISIS UPON NOTIFIED CASES.

| *Locality.* | *Administrative Unit.* | 1913. | 1914. | 1915. | 1916. |
|---|---|---|---|---|---|
| St. Helens | Co. Bo. | ... | ... | ... | 67·2 |
| Lancashire | C. C. | 53·4 | 54·0 | 56·2 | 62·7 |
| Carlisle | Co. Bo. | ... | 38·7 | 57·6 | ... |
| Wolverhampton | Co. Bo. | ... | ... | 60·8 | ... |
| Huddersfield | Co. Bo. | ... | 47·5 | 65·0 | ... |
| Birkenhead | Co. Bo. | ... | 45·6 | ... | 52·1 |
| Halifax | Co. Bo. | ... | 66·1 | 79·6 | ... |
| Northamptonshire | Urban and Rural | ... | 51·4 | 64·1 | ... |
| Northumberland | C. C. | ... | 67·0 | ... | ... |
| Chelsea | Met. Bo. | ... | 53·5 | 73·9 | 47·9 |
| Berkshire | C. C. | ... | 44·6 | 41·4 | ... |
| Crewe | M. B. | ... | 54·0 | ... | ... |
| Darlington | Co. Bo. | ... | 45·1 | ... | ... |
| Hull | Co. Bo. | ... | 60·2 | ... | ... |
| Holborn | Met. Bo. | ... | 80·0 | 45·1 | ... |
| St. Marylebone | Met. Bo. | ... | ... | 40·9 | ... |
| Lincolnshire—parts of Holland | C. C. | ... | 58·2 | ... | ... |
| Lincolnshire—parts of Lindsay | C. C. | ... | 71·5 | ... | ... |
| Poplar | Met. Bo. | ... | ... | 52·8 | ... |
| Essex | C. C. | ... | 40·6 | ... | ... |
| Leyton | U. D. | ... | 38·5 | ... | ... |
| Brighton | Co. Bo. | ... | 56·9 | ... | ... |
| Hove | M. B. | ... | 49·4 | 62·1 | ... |
| Bootle | Co. Bo. | ... | 35·0 | 45·7 | ... |
| Great Yarmouth | Co. Bo. | ... | ... | 108·7 | ... |
| Preston, Lancs. | Co. Bo. | ... | 37·5 | 38·3 | 37·4 |
| Colchester | M. B. | 34·3 | 49·5 | 78·8 | .. |
| Shropshire | C. C. | ... | 79·7 | ... | ... |
| Nottingham | Co. Bo. | 45·1 | 41·2 | ... | ... |

TABLE 15. CORRELATIONS BETWEEN DEATH-RATES FROM PULMONARY TUBERCULOSIS AND DEATH-RATES FROM ALL OTHER CAUSES AMONG WOMEN AGED 15–45 IN THE YEAR 1911.

| | |
|---|---|
| Metropolitan and County Boroughs | $r = 0.292 \pm 0.06$ |
| Urban districts | $r = 0.403 \pm 0.07$ |
| Rural districts | $r = 0.748 \pm 0.04$ |
| 33 large industrial towns | $r = 0.330 \pm 0.10$ |

TABLE 16. PROPORTIONATE MORTALITY AND DEATH-RATE (PHTHISIS). EXPERIENCE 1891–1900. 168 ENGLISH REGISTRATION DISTRICTS. (SEE TABLE 17 *b*.)

| *Proportionate Mortality.* | *Number of Observations.* | *Observed Mean Rate of Mortality.* | *Mean Rate of Mortality calculated from Regression Equation.* |
|---|---|---|---|
| 0·17 | 7 | 1·47 | 1·66 |
| 0·22 | 21 | 2·02 | 1·98 |
| 0·27 | 40 | 2·46 | 2·30 |
| 0·32 | 48 | 2·58 | 2·62 |
| 0·37 | 29 | 2·91 | 2·94 |
| 0·42 | 6 | 2·59 | 3·26 |
| 0·47 | 8 | 4·13 | 3·58 |
| 0·52 | 2 | 4·01 | 3·90 |
| 0·57 | 3 | 4·42 | 4·22 |
| 0·62 | 2 | 4·51 | 4·54 |
| 0·67 | 1 | 5·26 | 4·87 |
| 0·72 | ... | ... | 5·19 |
| 0·77 | ... | ... | 5·51 |
| 0·82 | 1 | 4·76 | 5·83 |

Goodness of Fit P = 0·27.
(See Pearson, *Biometrika* 1916, 11, 239.)

## TABLE 17 *a*.

OCCUPATIONS. AGES 35–45. MORTALITY 1900–2. R. G.

Proportionate Mortality (Ratio of Deaths from Phthisis to Deaths from all other causes) and Phthisis Death-rate.

| *Correlation.* | *Regression Equation.* |
|---|---|
| 0·754 ± 0·04 | $y = 0{\cdot}0473\,x + 0{\cdot}6309$ |

($y$ is the Death-rate, $x$ is Proportionate Mortality).

## TABLE 17 *b*.

168 REGISTRATION DISTRICTS, EACH OF MEAN POPULATION GREATER THAN 50,000. R. G. DECENNIAL SUPPLEMENT, 1890–1900.

| *Proportionate Mortality* ($x$). | | *Death-rate per* 1,000 *Persons* ($y$). | |
|---|---|---|---|
| *Mean.* | *Standard Deviation.* | *Mean.* | *Standard Deviation.* |
| 0·324 | 0·097 | 2·648 | 0·991 |

Coefficient of Correlation, 0·629 ± 0·03.
Correlation Ratio, 0·663.
(Death-rate on Proportionate Mortality.)
Regression Equation: $y = 6{\cdot}410\,x + 0{\cdot}570$.

TABLE 18. SHOWING *INCREASED* RATES OF DEATHS FROM TUBERCULOSIS AND ALL OTHER CAUSES, 1913–16.

Women, ages 15–45.

| *Metropolitan and County Boroughs.* | 1916. | 1915. | 1914. | 1913. |
|---|---|---|---|---|
| Battersea | ·50 | ·65 | ·43 | ·32 |
| Bermondsey | ·66 | ·54 | ·39 | ·41 |
| Bethnal Green | ·51 | ·43 | ·60 | ·45 |
| Camberwell | ·70 | ·50 | ·48 | ·39 |
| Deptford | ·58 | ·61 | ·60 | ·46 |
| Finsbury | ·67 | ·48 | ·27 | ·57 |
| Fulham | ·64 | ·48 | ·43 | ·41 |
| Greenwich | ·46 | ·54 | ·34 | ·34 |
| Hackney | ·60 | ·49 | ·46 | ·51 |
| Hampstead | ·49 | ·14 | ·37 | ·22 |
| Islington | ·50 | ·46 | ·35 | ·39 |
| Kensington | ·48 | ·38 | ·42 | ·34 |
| Lambeth | ·57 | ·41 | ·51 | ·46 |
| Lewisham | ·44 | ·47 | ·34 | ·27 |
| Poplar | ·51 | ·53 | ·34 | ·43 |
| St. Pancras | ·49 | ·43 | ·44 | ·28 |
| Shoreditch | ·47 | ·61 | ·54 | ·33 |
| Southwark | ·56 | ·36 | ·48 | ·49 |
| Stepney | ·52 | ·48 | ·38 | ·36 |
| Stoke Newington | ·36 | ·28 | ·46 | ·32 |
| Wandsworth | ·40 | ·55 | ·45 | ·31 |
| Westminster | ·33 | ·31 | ·29 | ·27 |
| Bath | ·50 | ·40 | ·31 | ·27 |
| Birkenhead | ·43 | ·32 | ·32 | ·31 |
| Birmingham | ·49 | ·39 | ·36 | ·35 |
| Blackburn | ·34 | ·29 | ·23 | ·22 |
| Blackpool | ·32 | ·32 | ·41 | ·19 |
| Bolton | ·35 | ·36 | ·39 | ·24 |
| Bootle | ·75 | ·48 | ·36 | ·37 |
| Brighton | ·51 | ·54 | ·54 | ·38 |
| Burnley | ·35 | ·25 | ·26 | ·28 |
| Burton-on-Trent | ·36 | ·63 | ·65 | ·33 |
| Bury | ·38 | ·62 | ·31 | ·37 |
| Canterbury | ·54 | ·17 | ·47 | ·32 |
| Coventry | ·49 | ·53 | ·46 | ·48 |
| Croydon | ·64 | ·45 | ·41 | ·42 |
| Derby | ·50 | ·36 | ·38 | ·48 |
| Dewsbury | ·31 | ·23 | ·31 | ·23 |
| Exeter | ·72 | ·79 | ·40 | ·40 |
| Gateshead | ·43 | ·40 | ·42 | ·37 |
| Gloucester | ·62 | ·59 | ·56 | ·47 |
| Grimsby | ·56 | ·41 | ·29 | ·47 |
| Halifax | ·32 | ·38 | ·40 | ·28 |
| Hastings | ·60 | ·51 | ·58 | ·27 |
| Huddersfield | ·34 | ·28 | ·18 | ·25 |
| Hull | ·57 | ·53 | ·37 | ·41 |
| Ipswich | ·48 | ·73 | ·58 | ·33 |
| Leeds | ·55 | ·43 | ·43 | ·38 |
| Leicester | ·79 | ·52 | ·54 | ·62 |
| Liverpool | ·51 | ·46 | ·48 | ·43 |
| Manchester | ·52 | ·48 | ·42 | ·42 |
| Middlesborough | ·42 | ·44 | ·29 | ·37 |
| Newcastle | ·46 | ·35 | ·38 | ·40 |
| Newport (Mon.) | ·44 | ·28 | ·45 | ·37 |
| Norwich | ·60 | ·61 | ·62 | ·37 |

## TABLE 18 (*continued*).

| *Metropolitan and County Boroughs.* | 1916. | 1915. | 1914. | 1913. |
|---|---|---|---|---|
| Nottingham | ·48 | ·55 | ·54 | ·39 |
| St. Helens | ·46 | ·22 | ·28 | ·43 |
| Salford | ·44 | ·54 | ·39 | ·37 |
| Sheffield | ·32 | ·33 | ·30 | ·27 |
| Smethwick | ·54 | ·36 | ·35 | ·50 |
| Southampton | ·61 | ·51 | ·51 | ·35 |
| Southend-on-Sea | ·64 | ·60 | ·37 | ... |
| Stoke-on-Trent | ·49 | ·37 | ·35 | ·38 |
| Cumberland | ·52 | ·44 | ·42 | ·39 |
| Wallasey | ·27 | ·31 | ·32 | ·24 |
| Walsall | ·52 | ·50 | ·34 | ·43 |
| Warrington | ·74 | ·48 | ·50 | ·35 |
| West Bromwich | ·43 | ·43 | ·46 | ·26 |
| Westham | ·50 | ·44 | ·43 | ·44 |
| Wolverhampton | ·51 | ·30 | ·29 | ·50 |
| York | ·42 | ·52 | ·38 | ·36 |
| Cardiff | ·62 | ·47 | ·49 | ·52 |
| Merthyr Tydfil | ·54 | ·42 | ·47 | ·46 |
| Swansea | ·69 | ·46 | ·65 | ·36 |

## TABLE 18*a*. *Administrative Counties.*

| *Urban and Rural Districts.* | 1916. | 1915. | 1914. | 1913. |
|---|---|---|---|---|
| Bedford U. | ·56 | ·28 | ·46 | ·46 |
| Berks. U. | ·46 | ·22 | ·35 | ·45 |
| Berks. R. | ·44 | ·38 | ·37 | ·37 |
| Bucks. R. | ·46 | ·27 | ·36 | ·36 |
| Cambridge U. | ·60 | ·27 | ·54 | ·35 |
| Cambridge R. | ·71 | ·31 | ·57 | ·38 |
| Cheshire U. | ·33 | ·37 | ·31 | ·32 |
| Cornwall U. | ·57 | ·53 | ·57 | ·55 |
| Cornwall R. | ·55 | ·40 | ·49 | ·49 |
| Derby U. | ·41 | ·37 | ·43 | ·31 |
| Derby R. | ·28 | ·37 | ·25 | ·26 |
| Devon U. | ·67 | ·38 | ·46 | ·56 |
| Devon R. | ·46 | ·56 | ·43 | ·45 |
| Dorset U. | ·51 | ·44 | ·43 | ·39 |
| Dorset R. | ·44 | ·31 | ·28 | ·40 |
| Durham U. | ·40 | ·36 | ·34 | ·35 |
| Durham R. | ·42 | ·41 | ·31 | ·30 |
| Essex R. | ·32 | ·43 | ·37 | ·30 |
| Hereford U. | ·67 | ·43 | ·57 | ·50 |
| Hereford R. | ·43 | ·67 | ·52 | ·42 |
| Hertford U. | ·38 | ·60 | ·32 | ·35 |
| Huntingdon R. | ·48 | ·58 | ·20 | ·47 |
| Isle of Ely U. | ·73 | ·38 | ·40 | ·62 |
| Isle of Ely R. | ·60 | ·23 | ·33 | ·26 |
| Kent U. | ·46 | ·42 | ·37 | ·37 |
| Lancaster U. | ·36 | ·38 | ·32 | ·31 |
| Lancaster R. | ·38 | ·28 | ·36 | ·27 |
| Lincoln (Holland) U. | ·59 | ·87 | ·28 | ·30 |
| Lincoln (Kesteven) U. | ·34 | ·29 | ·23 | ·25 |
| Lincoln (Kesteven) R. | ·60 | ·25 | ·30 | ·48 |
| Lincoln (Lindsay) U. | ·53 | ·39 | ·37 | ·40 |
| Lincoln (Lindsay) R. | ·62 | ·45 | ·40 | ·51 |
| Middlesex U. | ·47 | ·39 | ·38 | ·40 |
| Monmouth U. | ·36 | ·28 | ·26 | ·24 |
| Monmouth R. | ·74 | ·59 | ·50 | ·44 |
| Norfolk R. | ·62 | ·69 | ·42 | ·47 |
| Norfolk U. | ·61 | ·53 | ·47 | ·39 |
| Northumberland U. | ·57 | ·46 | ·85 | ·39 |
| Northumberland R. | ·38 | ·56 | ·41 | ·33 |

TABLE 18*a* (*continued*).

| *Urban and Rural Districts.* | 1916. | 1915. | 1914. | 1913. |
|---|---|---|---|---|
| Nottinghamshire U. | ·45 | ·30 | ·40 | ·31 |
| Oxfordshire R. | ·38 | ·47 | ·41 | ·26 |
| Peterborough U. | ·70 | ·24 | ·52 | ·44 |
| Shropshire U. | ·48 | ·35 | ·40 | ·31 |
| Shropshire R. | ·43 | ·42 | ·32 | ·29 |
| Somerset U. | ·43 | ·71 | ·53 | ·33 |
| East Suffolk U. | ·34 | ·31 | ·40 | ·25 |
| East Suffolk R. | ·41 | ·62 | ·42 | ·37 |
| West Suffolk U. | ·56 | ·67 | ·50 | ·55 |
| West Suffolk R. | ·74 | ·54 | ·29 | ·54 |
| Surrey U. | ·40 | ·38 | ·33 | ·32 |
| Surrey R. | ·51 | ·39 | ·37 | ·27 |
| West Sussex U. | ·50 | ·49 | ·53 | ·40 |
| East Sussex R. | ·86 | ·39 | ·55 | ·53 |
| East Sussex U. | ·67 | ·35 | ·24 | ·50 |
| Warwickshire U. | ·40 | ·41 | ·40 | ·16 |
| Warwickshire R. | ·38 | ·37 | ·40 | ·28 |
| Westmorland R. | ·30 | ·25 | ·32 | ·24 |
| Wiltshire R. | ·36 | ·48 | ·24 | ·28 |
| Worcestershire R. | ·40 | ·38 | ·55 | ·36 |
| Yorks., E. Riding U. | ·51 | ·37 | ·56 | ·24 |
| Yorks., E. Riding R. | ·55 | ·34 | ·48 | ·46 |
| Yorks., N. Riding U. | ·46 | ·27 | ·33 | ·44 |
| Yorks., N. Riding R. | ·30 | ·34 | ·41 | ·24 |
| Yorks., W. Riding U. | ·31 | ·27 | ·32 | ·30 |
| Anglesey R. | ·70 | ·70 | ·46 | ·63 |
| Brecknock R. | ·78 | ·29 | ·33 | ·76 |
| Carmarthen R. | ·60 | ·44 | ·66 | ·56 |
| Carnarvon U. | ·60 | ·32 | ·49 | ·59 |
| Carnarvon R. | ·86 | ·68 | ·60 | ·39 |
| Denbigh U. | ·56 | ·38 | ·56 | ·37 |
| Denbigh R. | ·43 | ·31 | ·46 | ·21 |
| Flint U | ·58 | ·32 | ·26 | ·46 |
| Glamorgan U. | ·45 | ·34 | ·33 | ·41 |
| Glamorgan R. | ·47 | ·44 | ·45 | ·33 |
| Merioneth U. | ·81 | ·20 | ·25 | ·50 |
| Merioneth R. | ·79 | ·67 | ·52 | ·36 |
| Montgomery R. | ·58 | ·53 | ·75 | ·48 |
| Pembroke U. | ·70 | ·42 | ·47 | ·39 |
| Pembroke R. | ·57 | ·43 | ·68 | ·48 |
| Radnorshire U. | ·63 | ·14 | ·33 | ... |
| Radnorshire R. | ·54 | ·67 | ·38 | ·50 |

TABLE 19. SHOWING RATIO OF DEATH FROM TUBERCULOSIS AND ALL OTHER CAUSES *NOT INCREASED*, 1913–16.

Women, ages 15–45.

| *County Boroughs.* | 1916. | 1915. | 1914. | 1913. |
|---|---|---|---|---|
| Barnsley | ·29 | ·27 | ·49 | ·29 |
| Barrow-in-Furness | ·29 | ·35 | ·40 | ·38 |
| Bournemouth | ·62 | ·84 | ·63 | ·89 |
| Bradford | ·32 | ·34 | ·52 | ·38 |
| Bristol | ·51 | ·54 | ·41 | ·51 |
| Chester | ·45 | ·38 | ·32 | ·48 |
| Chelsea | ·19 | ·39 | ·28 | ·20 |
| Dudley | ·37 | ·42 | ·38 | ·52 |
| Eastbourne | ·39 | ·31 | ·50 | ·44 |
| Great Yarmouth | ·75 | ·79 | ·70 | ·89 |
| Hammersmith | ·52 | ·40 | ·37 | ·54 |
| Holborn | ·31 | ·27 | ·53 | ·45 |

TABLE 19 (*continued*).

| *County Boroughs.* | 1916. | 1915. | 1914. | 1913. |
|---|---|---|---|---|
| Lincoln | ·26 | ·43 | ·29 | ·29 |
| Northampton | ·48 | ·58 | ·52 | ·49 |
| Oldham | ·32 | ·25 | ·28 | ·34 |
| Oxford | ·50 | ·44 | ·29 | ·61 |
| Paddington | ·38 | ·41 | ·43 | ·42 |
| Plymouth | ·49 | ·44 | ·48 | ·55 |
| Portsmouth | ·36 | ·35 | ·46 | ·47 |
| Preston | ·38 | ·35 | ·28 | ·39 |
| Reading | ·41 | ·32 | ·55 | ·49 |
| Rochdale | ·35 | ·28 | ·29 | ·49 |
| Rotherham | ·39 | ·37 | ·45 | ·50 |
| St. Marylebone | ·25 | ·28 | ·36 | ·39 |
| Southport | ·33 | ·25 | ·32 | ·35 |
| South Shields | ·31 | ·71 | ·45 | ·43 |
| Stockport | ·42 | ·48 | ·51 | ·50 |
| Tynemouth | ·37 | ·52 | ·48 | ·38 |
| West Hartlepool | ·49 | ·37 | ·26 | ·70 |
| Wigan | ·34 | ·27 | ·29 | ·35 |
| Woolwich | ·34 | ·39 | ·41 | ·49 |
| Worcester | ·51 | ·45 | ·39 | ·52 |

| *Administrative Counties. Urban and Rural Districts.* | 1916. | 1915. | 1914. | 1913. |
|---|---|---|---|---|
| Bedford R. | ·61 | ·59 | ·40 | ·72 |
| Bucks. U. | ·33 | ·55 | ·39 | ·44 |
| Chester R. | ·20 | ·22 | ·22 | ·34 |
| Cumberland U. | ·43 | ·35 | ·44 | ·50 |
| Cumberland R. | ·30 | ·35 | ·47 | ·47 |
| Essex U. | ·40 | ·38 | ·38 | ·41 |
| Gloucester R. | ·39 | ·44 | ·36 | ·42 |
| Gloucester U. | ·45 | ·48 | ·47 | ·62 |
| Hertford R. | ·38 | ·39 | ·35 | ·45 |
| Huntingdon U. | ·23 | ·33 | ·19 | ·53 |
| Isle of Wight R. | ·22 | ·53 | ·33 | ·41 |
| Isle of Wight U. | ·18 | ·50 | ·33 | ·41 |
| Kent R. | ·46 | ·47 | ·48 | ·47 |
| Leicester R. | ·51 | ·45 | ·55 | ·61 |
| Leicester U. | ·33 | ·47 | ·70 | ·51 |
| Lincoln R. | ·45 | ·45 | ·34 | ·71 |
| Middlesex R. | ·52 | ·26 | ·50 | ·63 |
| Northampton R. | ·53 | ·42 | ·48 | ·60 |
| Northampton U. | ·62 | ·76 | ·38 | ·62 |
| Nottinghamshire R. | ·35 | ·31 | ·36 | ·39 |
| Oxford U. | ·65 | ·41 | ·39 | ·83 |
| Peterborough R. | ·40 | 1·5 | ·60 | ·50 |
| Rutland R. | ·11 | ... | ·17 | ·21 |
| Rutland U. | ... | ... | ... | ·50 |
| Somerset R. | ·40 | ·51 | ·39 | ·43 |
| Southampton R. | ·39 | ·44 | ·50 | ·40 |
| Southampton U. | ·31 | ·35 | ·35 | ·58 |
| Stafford R. | ·32 | ·43 | ·38 | ·32 |
| Stafford U. | ·39 | ·33 | ·38 | ·43 |
| Sussex W. R. | ·46 | ·38 | ·49 | ·55 |
| Westmorland U. | ·19 | ·35 | ·40 | ·33 |
| West Yorkshire R. | ·34 | ·33 | ·30 | ·40 |
| Wiltshire | ·33 | ·23 | ·34 | ·33 |
| Worcester U. | ·43 | ·32 | ·37 | ·44 |
| Anglesey U. | ·38 | ·40 | ·70 | ·46 |
| Brecknock U. | ·30 | ·53 | ·45 | ·36 |
| Cardigan U. | ·64 | ·60 | ·25 | ·67 |
| Cardigan R. | ·62 | ·80 | ·79 | ·71 |
| Carmarthen U. | ·43 | ·62 | ·36 | ·53 |
| Flint R. | ·33 | ·26 | ·34 | ·43 |
| Montgomery U. | ·05 | ·64 | ·33 | ·54 |

## Table 20 *a*. Industrial Towns and Boroughs.

| *Ratio Increased.* | | *Ratio not Increased.* |
|---|---|---|
| Bermondsey | Huddersfield | Barrow-in-Furness |
| Bethnal Green | Hull | Bradford |
| Deptford | Ipswich | Chester |
| Finsbury | Leeds | Dudley |
| Fulham | Leicester | Northampton |
| Greenwich | Liverpool | Oldham |
| Hackney | Manchester | Preston |
| Lambeth | Middlesborough | Reading |
| Poplar | Newcastle | Rochdale |
| St. Pancras | Newport (Mon.) | Rotherham |
| Shoreditch | Norwich | South Shields |
| Southwark | Nottingham | Stockport |
| Stepney | St. Helens | Tynemouth |
| Birkenhead | Salford | West Hartlepool |
| Birmingham | Sheffield | Wigan |
| Blackburn | Smethwick | Woolwich |
| Bolton | Stoke-on-Trent | |
| Bootle | Sunderland | |
| Burnley | Wallasey | |
| Burton-on-Trent | Walsall | |
| Bury | Warrington | |
| Coventry | West Bromwich | |
| Croydon | West Ham | |
| Derby | Wolverhampton | |
| Dewsbury | Cardiff | |
| Gateshead | Merthyr Tydfil | |
| Halifax | Swansea | |

## Table 20 *b*. Non-Industrial Towns and Boroughs.

| *Ratio Increased.* | *Ratio not Increased.* |
|---|---|
| Battersea | Chelsea |
| Camberwell | Hammersmith |
| Hampstead | Holborn |
| Islington | Paddington |
| Kensington | St. Marylebone |
| Lewisham | Bournemouth |
| Stoke Newington | Eastbourne |
| Wandsworth | Great Yarmouth |
| Westminster | Lincoln |
| Bath | Oxford |
| Blackpool | Portsmouth |
| Brighton | Plymouth |
| Canterbury | Southport |
| Exeter | Worcester |
| Gloucester | |
| Grimsby | |
| Southampton | |
| Southend-on-Sea | |
| Hastings | |
| York | |

## Part V. The Factory Conditions Observed in Birmingham in 1917.

In order to get some idea of the present distribution of Pulmonary Tuberculosis in an industrial population, so far as it is possible to do so by the study and analysis of a small sample, an investigation was carried out at Birmingham in November–December 1917, the data made use of and the method adopted being the following:

The Special Investigation Committee upon the Incidence of Phthisis in relation to Occupations appointed by the Medical Research Committee of the National Health Insurance Commission had already available a considerable body of information on this matter in the form of a card-index referring to certain large manufacturing towns (Manchester, Sheffield, Birmingham, Belfast, &c.). A request had been made in each instance to the Medical Officer of Health, Chief Tuberculosis Officer or other responsible authority for a return both current and retrospective of all persons notified for Tuberculosis who were also engaged in any industry or occupation.

Among the places mentioned Birmingham was chosen as being possibly that best suited for the inquiry projected, since it fairly represents in all essential ways average conditions of life of the working folk in a large industrial centre, and also for the fact that Ministerial control gave a wide portal of entry into workshops of all types and sizes, such as could not at the present time have been obtained by any other means.

A preliminary scrutiny of the cards which had accumulated for Birmingham during the period of six years since voluntary, and later compulsory, notification of Tuberculosis began (viz. December 1911–November 1917) showed them to include the names of 972 persons referable to firms under the control of the Ministry of Munitions. A second sorting was by industries, which being found to be numerous as well as very varied in character, necessitated some further limitation.

Birmingham's leading industry, the non-ferrous metal trade, was therefore selected, since it draws by far the greater part of the working population, at all ages, into its net, and such avocations were chosen as could be embraced by this general designation; and again, since it would have been impossible to visit every one of the 202 controlled establishments named on the cards (although large, medium-sized, and small works were included for examination), those containing the smallest numbers of hands, and in which usually not more than a single case of Tuberculosis had occurred during the whole-time period involved, were rejected.

Forty works were visited and since particular trades tend to settle in particular neighbourhoods, a principle adopted was to include at least one establishment in each important trade area or district.

A thorough inspection in detail of the whole of the premises connected with each works or firm visited was in all cases made; a full explanation of the objects of the inquiry was found to be an

effective means of securing the willing consent and co-operation of the manager, or other representative, and whenever possible the assistance of the Welfare Supervisor was obtained in going round, on account of her wide personal acquaintance with the employees. Large numbers of people occupied on all sorts of work were seen. The general structure, aspect, means of heating and ventilation, the lighting of premises and of the work, numbers of employees, their position while at work and relative to one another, the machines, tools and materials, hours of work and of rest, trade habits and factory hygiene were gone into, as well as all other matters which have been thought to influence or affect in any way the incidence or prevalence of Tuberculosis in workshops.

After inspecting the factories a series of visits was made to the homes of notified persons.

The Tuberculosis Department divides up the whole city into ten administrative areas, each of which has its own Tuberculosis Visitor. By the courtesy of the Medical Officer of Health I was enabled to obtain the assistance of the latter in arranging itineraries so as to traverse the whole district and so to distribute my visits as to take in streets and houses in each area, and in this way to get a fairly comprehensive view of working-class housing conditions in Birmingham generally and more particularly of those of the persons under review.

In all the works inspected, as many of the notified persons as could be identified were briefly questioned about themselves. In 162 cases, in addition to this, it was found possible to verify or to correct, as well as to amplify the information returned on their cards, and so to render the latter sufficiently exact for tabulation.

Of these 162 persons 105 were males and 57 females. Table I gives their sex and age distribution, the latter being put into the most usual quinquennial and decennial periods.

TABLE I.

| *Ages at Date of Notification.* | *Males.* | *Per Cent.* | *Females.* | *Per Cent.* |
|---|---|---|---|---|
| 15–20 (inclusive) | 14 | 8·6 | 15 | 9·3 |
| 21–25 ,, | 18 | 11·1 | 14 | 8·6 |
| 26–35 ,, | 32 | 19·7 | 18 | 11·1 |
| 36–45 ,, | 26 | 16·6 | 10 | 6·1 |
| 46–55 ,, | 11 | 6·7 | ... | ... |
| 56 and upwards | 1 | 0·6 | ... | ... |
| Ages not known, or not stated | 3[1] | 1·8 | ... | ... |

[1] 1. A cured case. Now in Army. Mother and home seen.
2. Father of a case on cards, working at same firm as daughter. Notified, but not indexed.
3. Husband of a case on cards. Invalided out of Army; seen while calling on wife. Not indexed.

Table II is a list giving the original trade designations of the firms visited—many of which have more than one works in Birmingham.

TABLE II.

| | |
|---|---|
| Electro-platers | 1 firm |
| Engineers | 1 ,, |
| Guns and small arms | 1 ,, |
| Brass and copper founders | 1 ,, |
| Wire-rope and wire makers | 1 ,, |
| Coining | 1 ,, |
| Metal and alloy merchants | 2 firms |
| Motor-car builders | 2 ,, |
| Cycle and other chain makers | 2 ,, |
| Lamp-makers | 2 ,, |
| Ammunition makers | 2 ,, |
| Silversmiths | 2 ,, |
| Tube-makers and rolling mills | 3 ,, |
| Motor and cycle accessories | 3 ,, |
| Pen-makers | 3 ,, |
| Nail and screw makers | 3 ,, |
| Electric fittings and engineers | 3 ,, |

Table III gives the distribution by original occupations, i. e. the kind of work engaged in by each person at the date of notification.

The majority of these persons being still at work, many of them are now actually employed on munitions of one kind or another. Obviously, all the firms inspected, being 'Controlled Establishments', are doing war work—but since the term 'Munitions of War' includes, in addition to shells, cartridges, fuses, aeroplanes, &c., everything required by or referable in any way to an army in the field, it follows that many of the goods originally produced continue to be required and are still being made in large quantities. Also that where, as in many cases, by expansion or extension of premises the manufacture of articles of a different kind has also been undertaken by a firm, the aim has usually been to choose that for which the nature of the material used, the machinery already installed, and the skill of the workers employed therein can be most readily adapted. Hence, those who were formerly pen-makers, will now be found engaged on such things as cartridge-clips, for both are worked out of thin sheet metal; screw makers will be making rivets and bolts for aeroplanes; tin-plate workers, mess-tins; silversmiths, friction-tubes (which contain an interior mechanism requiring a nice adjustment)—and so on. Thus there is a very close correlation between much of the former work and that now being done by many munitionists, while in not a few cases it remains actually the same, though doubtless it is being done at a much greater speed.

Hence, while notifications in some instances date back to pre-war days, work done then and now may often be strictly comparable, since neither in kind of material used, nor in size of work, nor in tools, machinery, position while working, &c, is there any essential difference.

## Table III. Occupations. (161 Cases.)

| *Nature of Occupation.* | *No. of Cases.* |
|---|---|
| Machinists | 27 |
| Filers (18) and drillers (3) | 21 |
| Wire-rope and rope makers and wire drawers | 13 |
| Metal turners, and working lathes and capstans | 8 |
| On rifles and Lewis gun, and gun-finishers | 8 |
| Polishers | 7 |
| Tool-makers | 9 |
| Fuse-makers (4) and coin sorters (5 | 9 |
| Casters and annealers (5), rollers (2) | 7 |
| Fitters (6) and smiths (3) | 9 |
| Motor-engine and crane-drivers (3), labourers (out-door) (6) | 9 |
| Pen processes (2), aluminium welders (2), sand-blasters (2) | 6 |
| In warehouse and packers | 7 |
| Clerks, typists, and book-keeper | 4 |
| *Miscellaneous (one of each)*— | |
| *F.* Razor-grinder, chain riveter, armature-winder, 'toster', cook, screwer-in | 17 |
| *M.* Electrician, water-tester, joiner, assembler, die-lapper, mechanic, lamp-maker, cycle work, wood-turner, printer, boiler-tube heater | |

The above figures do not of course throw light upon the prevalence of phthisis among the occupations enumerated because, although we know the total populations of the factories, we do not know the occupational distribution within each factory. Such information is naturally unobtainable since the proportion engaged upon each type of work depends upon such variables as contracts in hand, materials obtainable, &c.

The whole of the works visited may for description be conveniently placed, and indeed they fall naturally into two categories or types, *A* and *B*.

*A*. Large, modern, well-constructed and properly equipped establishments which, according to accepted views, conform in a high degree to nearly all such conditions as constitute for the workers a healthy factory environment.

*B*. Those others of an almost directly opposite type, in which hygienic measures, if indeed ever seriously considered at all, are as antiquated as is their construction, and to which the term haphazard most fittingly applies.

### *Type A.*

Usually these are very large buildings of recent date (several built since the war) but seldom older than ten to fifteen years; the skeleton is either of steel or ferro-concrete, &c., or, where rather older, of brick or stone, but in either case filled in with a large proportion of glass, the newest having the appearance of huge glass boxes. The

disadvantages of glass for walls lie in two of its physical properties—its imperviousness to air and its diathermancy—so that by its use for this purpose one means of ventilation is lacking which bricks and all other pervious materials possess, namely, that slow but continuously acting interchange between the outer pure and usually cooler and the inner contaminated and usually warmer air; and also that internally such glass-walled and glass-roofed enclosures will be much less equable in temperature than buildings walled and roofed with ordinary and opaque materials, tending to be too hot in summer and too cold in winter. Standing as they generally do on ample ground space, free access of sunlight, daylight, and air reaches them and overshadowing by other buildings is practically impossible. A good orientation can also be secured. Several had roof-lights facing north, but employees usually find these unduly cold in winter, and special heating is necessary to remedy this.

The great disadvantage of north lighting as regards Tuberculosis is that during all the darkest and coldest days of our long winter, places so situated will receive a minimum of sunlight and daylight, whereas from all that is known of the lethal effects of sunlight on the Tubercle Bacillus the aim should be to secure the maximum; more particularly at a time of year when consumptives and others are coughing most and the risk of massive infection is greatest.

These works are always provided with means for heating—either hot-air, hot-water, or steam pipes being fixed at various levels or radiators installed. The exception is in some ground-floor shops, when, for example, these are very lofty, to take the biggest work and machines, and have also usually wide doors and other openings; heating would in such cases be practically useless and is not often attempted. Shops of this description are generally very cold in winter, and there is much complaint from workers in them—improvised fires in pails are frequently seen.

Ventilation also has always received consideration by the designers, and various well-known systems of ventilation were observed. Also electric fans were often seen in use to meet special cases, but as so often happens, owing to wrong levels being chosen, and mal-adjustment of the direction of the air-stream at those levels, for purposes of effective ventilation they were in many cases quite useless.

Apart from special systems of ventilation, however, in all works in category *A* apportionment of windows is very liberal, and all measures and apparatus for their proper opening and adjustment are usually in good order, so that in the great majority of instances effective 'natural ventilation' by this means should be obtainable under all ordinary circumstances.

Unfortunately, however, and this applies also very largely to heating, while installations and other means to secure these two ends have been provided—often at great cost—their regulation is in most cases entirely fortuitous and what is nobody's business very soon becomes the business of one or more of the workers themselves, and it will usually be those most unsuitable of all to perform these

functions. Hence it frequently happens that in one shop an old bronchitic male and in another some weak, anaemic girl (both with an equal horror of fresh invigorating air—'a dislike of draughts' they phrase it) is allowed to dominate the ventilation and heating arrangements for a hundred or more healthy persons!

In all places where large numbers of workers are employed for many hours on such continuous tasks as are here seen the air temperature tends gradually to rise as the hours pass; naturally this requires regulation, and it should be the prescribed duty of some responsible person to watch the thermometer and to attend to this matter.

Many shops were seen towards the end of work time. Far more often than not the temperature of them had risen too high for comfort, health, and efficient working, and it is no uncommon thing to see hundreds of girls trooping out of workrooms into the cold night air, and all with flushed and perspiring faces.

With due attention to window and other ventilation this overheating need scarcely ever occur—but as a matter of actual observation in these and in all the shops visited, windows are scarcely ever made sufficient use of. Many records were made both of factory and house windows, but are too long for quotation—a single one will suffice. In one of the largest and possibly the best factory in Birmingham, on a fine, bright, sunny, and windless day, there were open in one half of an immense shop (made up of 900 similar lights 24″ × 18″ each) only eight (8) out of a possible forty-five (45) which were made to open—and in the other precisely similar half, not a single one! It is no uncommon thing here to pass factory after factory without seeing a single window open.

The general lighting in all *A* factories is extremely good. A certain amount of obscuring of the glass is necessary to temper the sunlight in summer; also dust and dirt accumulate to some extent on the outside; but on all fine days they are flooded in every corner with sunlight and daylight. Lighting of the work itself is also invariably good and can therefore be dismissed at once.[1]

The standard of cleanliness in *A* shops is usually of the highest. The only dirt generated is metal swarf and dust, both of which being valuable are quickly collected and sent away, and as most of the machine work is 'wet work' very little dust can possibly be inhaled. The very nature of much of the work and of the machines makes cleanliness a necessity. In the polishing and filing shops more dust, and that of a more objectionable character, is generated, and being both finer and lighter than metal dust could more easily be inhaled; but adequate exhausts are provided, and, except immediately around a polisher, there is astonishingly little accumulation of dust by the end of the day.

Enormous numbers of people are now employed in these shops, chiefly on repetition work, and while it is true that these numbers may vary from time to time according to the contracts in hand, &c., in most of them the only limit seems to be one of floor space. In

[1] Its influence with regard to tuberculosis would only be manifest when lighting of the work was so bad as to compel workers habitually to assume a cramped position while at work, thus restricting chest movements and pulmonary ventilation.

other words, in each shop there are just as many people as the size of the machines and the nature of the work will permit. The workers sit or stand in long rows, and although often nearer to one another in the rows than is desirable, the machine and work determine the actual distance; this however is rarely, if ever, dangerously near. The risk of a massive infection from another open case would be far more likely to occur when the rows which face one another are too near. This I never saw—three feet apart being the minimum distance observed, and rarely was it less than 3 ft. 6 in. or 4 ft., with, in most cases, intervening machines at head level.

The nearest approach to a dangerous proximity is to be seen in some viewing and gauging departments, and in certain operations on very small articles or parts. In one such case a large roomful of girls were working with small drilling machines on friction tubes. They were so close together that their elbows could touch and even overlap one another.

On repetition work in *A* factories, only one departure from the linear arrangement of workers came under my notice. In the assembling of certain fuses sixty girls in one room sat in groups of four, their bent heads nearly touching. Such position and proximity is certainly undesirable, and could easily give rise to the infection of a susceptible individual were one of the group to have open phthisis. There was, however, no notified case here, nor was there known to have been a case in this room during the period of this particular operation.

### *Type B.*

Under *B* are comprised older and usually smaller workshops. The chief determining factor has been their age—since it is rare to find a factory older than about twenty years which at all conforms to the standard of hygiene which is now known to be absolutely essential for health. Some of these have been built fifty years and more. Many of them have been enlarged to meet growing business by the promiscuous tacking on here and there of additions of various sizes, and in various positions. All suggestion of original design is thus lost; daylight and sunlight are excluded from inner parts as well as access of fresh air, and nothing can improve or remedy such defects. Others, originally standing free, have now become built up on one, two, or three sides, so as to be completely wedged in. In yet other cases adjoining premises which are quite unsuitable for factory purposes have been connected by means of doors and passages.

Roofs and ceilings are often very low, unduly restricting air space—windows are usually small, many are cracked and broken, all are usually very dirty, some absolutely opaque, and scarcely any can be properly opened. Owing to the peculiar disposition of stairways, passages, and doors some of these shops are extremely draughty and cold, while into others a current of fresh, moving outside air could not possibly be made to penetrate.

By reason of their darkness artificial lighting has often to be used all day; frequently this is by gas, in which case there is permanent overheating as well as some contamination of the air.

In nearly all of them the floors are of wood, badly laid, often very dirty, and in some cases actually in holes. Unnecessary ledges and projections abound, affording unlimited opportunities for the conservation of dust and dirt.

Many other defects in these shops could be enumerated, but sufficient has been said to show the ineradicable quality of those mentioned. Nothing short of demolition and rebuilding could convert them into such places as ought to be offered to those whose working days must be lived in them.

As regards numbers and position of workers in *B* factories, relatively to floor space these are practically the same as in Type *A*, that is to say every inch of space is occupied by workers. But since the cubical contents of these shops are so much less, and measures for changing and freshening the air in them are either defective or non-existent, the chances of workers as regards maintaining a high level of health while working in them will certainly be less favourable in comparison with those spending their working hours in *A* shops.

A special inquisition into the possibilities of *direct Tubercular infection* through the agency of tools or materials, or in any other way, was made in each of the works visited (both in Class *A* and *B*), as well as into the question of spitting. As regards the latter practice, which is of course prohibited everywhere, though with varying degrees of severity, one could not fail to remark the exceedingly scanty evidence of it on the floors of stairs and passages, lavatories, W.Cs., and in any parts of these works as compared with other large workshops examined, in London and in the Northern Counties. Indeed in most of them there were no visible signs of it at all. Where chiefly women or women and girls alone are employed this is, of course, not remarkable. Closer inquiry, however, brought to light another practice which was known of everywhere, and which there was reason to think may be followed to a greater or less extent in all of them. I refer to what is here known as 'spitting in the suds', i.e. spitting into the receptacles which hold the lubricant mixture found in all shops where 'wet' metal work is done. It is a disgusting and possibly a dangerous habit, since this mixture is frequently sprayed on to people's clothes, and the hands of workers are constantly wet with it. Whether its causticity and the disinfectants which are added to it in some works are a sufficient safeguard, experimental research alone could show.

As regards the materials and tools used—the nature and physical properties of the former (viz. the non-ferrous metals) practically preclude the possibility of tuberculous sputum adhering to it, and the same may be said with regard to tools, gauges, &c., which are all of metal.

No evidence of any dangerous 'trade habit' such as occurs in certain industries was discovered which could be instrumental in transmitting this infection from one operative to another.

Table IV shows the distribution of cases between factories referable to the two main types, *A* and *B*. It will be noticed that whichever basis of population be adopted, that of 1914 or that of 1917, the proportion of the cases visited which is derived from *B* factories is considerably greater than one would anticipate upon the basis of population alone. Thus the cases are in the ratio of 1·9 to 1, as between *A* and *B* factories, while the 1914 populations are in the ratio of 3·4 to 1, and the 1917 populations in the ratio of 10·3 to 1. Much weight cannot perhaps be assigned to this discrepancy,[1] but it is consistent with the view above developed that the general circumstances of the *B* factories are unfavourable to health.

Certain particulars were ascertained bearing upon hereditary tendency. They are set out in Table V, which shows that in 43 cases, or 26·54 per cent., other cases of tuberculosis in these families have been notified, or there have been deaths of other members of the family from this cause, and in some cases both deaths and other cases.

In considering the etiology of tuberculosis, while in the past doubtless too great a share has been attributed to heredity, it will be admitted by all observers that what in comprehensive phrase has been called 'soil' at least plays an important rôle therein. This much it is at any rate safe to say, that while possibly no one, given sufficiently prolonged or repeated exposure to the contagion of tuberculosis, can be looked upon as being totally invulnerable, on the other hand we undoubtedly find that certain individuals and certain families appear to be much more susceptible than others.

But since infection is possible at any age, and the possibility of latency being admitted, it is obvious that until all the offspring of any tuberculosis-tainted union have completed their span of life our information as regards heredity (even for such single unit of a generation) cannot be complete.

Again, in the cases now under consideration, the insuperable difficulty arises that in respect of heredity these actually constitute *a picked sample*, referring as they do solely to families in which we have the definite information that at least one case of tuberculosis has occurred. No study or consideration of those families alone can afford us any just criterion as to proportion in the matter of heredity. In order to determine this, obviously we must have for comparison or control one or more samples of equal size and of like content (that is to say, samples strictly comparable in respect of sex, age-periods, social status, &c.), but made up of individuals who have *not* been notified for tuberculosis. Inquiries would then have to be made as to heredity in the families of all these individuals, and then a comparison instituted between these groups. This question, however, was not included among—was no doubt intentionally excluded from—those asked on the cards.

[1] The ratio of total notifications is 4·9 to 1 and of average populations 7·1 to 1, but the notifications cover 1911–17, the populations 1914–17.

## Table IV. A. Factories.

| *Distinguishing Number of Factory.* | *Number of Employees in 1914.* | *Number of Employees in 1917. (Date of Inquiry.)* | *Notified Cases of Tuberculosis investigated.* | | | *Notified Cases during the whole Period of Notification (1911–17).* | | |
|---|---|---|---|---|---|---|---|---|
| | | | *Number of Cases.* | *Males.* | *Females.* | *Males.* | *Females.* | *Totals.* |
| 1 | 415 | 232 | 3 | 0 | 3 | 0 | 4 | 4 |
| 2 | 716 | 502 | 4 | 2 | 2 | 3 | 3 | 6 |
| 3 | 887 | 3,312 | 20 | 14 | 6 | 12 | 6 | 18 |
| 4 | 905 | 11,869 | 1 | 0 | 1 | 32 | 30 | 62 |
| 5 | 1,195 | 766 | 7 | 4 | 3 | 9 | 8 | 17 |
| 6 | 1,126 | 8,137 | 3 | 1 | 2 | 30 | 28 | 58 |
| 7 | 1,344 | 10,131 | 41 | 27 | 14 | 77 | 17 | 94 |
| 8 | 1,473 | 1,235 | 14 | 14 | 0 | 18 | 0 | 18 |
| 9 | 1,564 | 1,671 | 10 | 2 | 8 | 3 | 10 | 13 |
| 10 | 2,401 | 12,374 | 2 | 1 | 1 | 27 | 27 | 54 |
| 11 | 4,354 | 6,563 | 2 | 1 | 1 | 56 | 3 | 59 |
| | 16,380 | 56,792 | 107 | 66 | 41 | 267 | 136 | 403 |

## Table IV *a*. B. Factories

| *Distinguishing Number of Factory.* | *Number of Employees in 1914.* | *Number of Employees in 1917. (Date of Inquiry.)* | *Notified Cases of Tuberculosis investigated.* | | | *Notified Cases during the whole Period of Notification (1911–17).* | | |
|---|---|---|---|---|---|---|---|---|
| | | | *Number of Cases.* | *Males.* | *Females.* | *Males.* | *Females.* | *Totals.* |
| 12 | 110 | 110 | 2 | 1 | 1 | 1 | 1 | 2 |
| 13 | 235 | 776 | 2 | 0 | 2 | 0 | 2 | 2 |
| 14 | 304 | 275 | 3 | 0 | 3 | 1 | 4 | 5 |
| 15 | 414 | 467 | 5 | 2 | 3 | 2 | 5 | 7 |
| 16 | 423 | 979 | 15 | 3 | 12 | 15 | 3 | 18 |
| 17 | 440 | 500 | 9 | 8 | 1 | 9 | 1 | 10 |
| 18 | 487 | 466 | 2 | 2 | 0 | 9 | 0 | 9 |
| 19 | 508 | 353 | 5 | 5 | 0 | 5 | 2 | 7 |
| 20 | 550 | 452 | 2 | 1 | 1 | 6 | 0 | 6 |
| 21 | 630 | 528 | 9 | 5 | 4 | 6 | 5 | 11 |
| 22 | 700 | 590 | 1 | 0 | 1 | 4 | 1 | 5 |
| | 4,801 | 5,496 | 55 | 27 | 28 | 58 | 24 | 82 |

Table V gives under their initials for each sex the 43 cases in which either one or more relations are known either to be suffering from or to have died of tuberculosis.

## Table V.

F. = father. M. = mother. B. = brother. Si. = sister. So. = son. D. = daughter. U. = uncle. A. = aunt. GF. = grandfather. GM. = grandmother. W. = wife.

| Males (22 *Cases*). | | | Females (21 *Cases*). | | |
|---|---|---|---|---|---|
| *Initials.* | *Relations dead from Tuberculosis.* | *Relations notified for or known to be suffering from Tuberculosis.* | *Initials.* | *Relations dead from Tuberculosis.* | *Relations notified for or known to be suffering from Tuberculosis.* |
| — D. | GF. | F., Si. | E. L. | F. | M. |
| R. W. | B. — So. (2 | So. | E. E. | F., Si. | ... |
| J. C. | ... | B. | E. C. | ... | D. |
| J. B. | Si. | ... | A. A. | ... | B. |
| A. W. | F. | ... | D. B. | F. | ... |
| — S. | ... | D. | A. R. | GF., B. (2), Si. | ... |
| H. A. | F. | B., Si. | — H. | F. | ... |
| G. B. | ... | B., Si. (2) | D. B. | M. | .. |
| W. T. | ... | So. (2) | L. S. | .. | F. |
| E. J. | ... | B. | S. L. | M., B. | ... |
| T. J. | ... | B. | — H. | F. | ... |
| T. H. B. | So. (2) | W. | — P. | A. | ... |
| W. B. | B. | ... | A. S. | B. | ... |
| A. T. | ... | W., So. | A. E. | M., F. | ... |
| W. B. | B. (2) | ... | M. D. | ... | B., Si. |
| W. S. | M. | ... | L. H. | M. | D. |
| H. T. B. | ... | So. | F. B. | F. | M. |
| G. C. | ... | W., So. | A. B. | ... | B., Si. |
| E. B. | ... | D. | — B. | ... | F. |
| G. E. L. | ... | B. (2), A. | G. L. | GM., A. | ... |
| G. J. | ... | M., Si. (2 | M. A. | B., Si. | ... |
| — T. | U. (2) | B., Si. | | | |

Table VI gives details with regard to contacts, or possible sources of infection in the home; that is to say, that in addition to the person named on the card it was ascertained that there was also, living in the same house, in certain instances one or more other persons suffering from tuberculosis (the majority were notified cases).

Among the 162 cases analysed there were 52 such instances, or 32 per cent., distributed as follows:

## Table VI.

| *Number of Contacts.* | *In Instances.* | *Sex of Person Notified.* | | | |
|---|---|---|---|---|---|
| | | *Males.* | *Per Cent.* | *Females.* | *Per Cent.* |
| One or more contacts | 52 | 33 | 20·3 | 19 | 11·6 |
| One contact | 31 | 19 | 11·6 | 12 | 7·4 |
| Two contacts | 17 | 10 | 6·1 | 7 | 4·3 |
| Three contacts | 4 | 4 | 2·4 | 0 | ... |
| One contact (definite), with one or more others probably so | 10 | 10 | 6·1 | 0 | ... |
| One or more contacts reported but not verified | 6 | 4 | 2·4 | 2 | 1·1 |

Table VII gives the localities in which the 162 persons under consideration were domiciled. For the following reasons it may be looked upon as affording some measure, though necessarily but a rough one, of their housing conditions.

Birmingham for municipal purposes is divided into 30 wards. For sanitary administration and statistical purposes (particularly with reference to zymotic disease incidence) these have been grouped into three areas, known respectively as the Central Wards, the Middle Ring, and the Outer Ring. In the first of these groups it is well known that there is much crowding of the population and that industrial housing conditions are the worst in Birmingham. These tend to improve somewhat in the middle zone, and still further to do so in the outer ring or suburban area, where there is necessarily more building space and room for expansion.

The housing generally of the Birmingham populace, however, is notoriously bad, and has long been so. So unsatisfactory indeed has it been that in 1901 public attention was drawn to the matter, and again in May 1913, when a special Committee was formed by the City Council which was empowered to investigate thoroughly and to report upon the whole question. An interim Report was issued on October 20th, 1914, and a passage from this may be quoted here since it contains the pith of the matter.

It reads: "Birmingham contains a vast number of small houses, in courts and terraces, mostly of the back-to-back type. They are in many ways undesirable dwelling-houses owing to the small size of their rooms, the want of through ventilation, and in many cases to the fact that they get no sunlight. But much more important than these defects is the inadequacy and publicity of their common conveniences, which form the 'true scandal to civilization', and make it difficult for the inhabitants to lead decent and healthy lives."

Reasons were given (which need not be gone into here) to show why these conditions were being maintained, and the impossibility of looking for any amelioration of them except by making use of the powers of the Sanitary Authority. The outcome of this inquiry was the formation of a scheme for clearance and rebuilding of the central area, and the acquirement of vacant areas for building more suitable houses and tenements in the outer ring, and but for the war this would have been put into operation forthwith. Unfortunately, however, for the present things remain as they were, and that the above report and condemnation merely states the plain facts was fully borne out by this inquiry.

As regards the case incidence of tuberculosis, it has been observed for many years now that this is highest in the central (crowded) area, and decreases in the middle ring, and still more so in the outer ring. For instance, in 1912 it was $2\frac{1}{2}$ times as high in the central as in the outer ring; in 1913 the averages for the Central, Middle and Outer wards were 7·3, 3·47, and 2·7 respectively, and in 1914, 5·4, 3·7, and 2·2, and though later figures have not been published, the Medical Officer of Health states that a similar ratio of case incidence has continued up to the present time.

In the cases here analysed the greatest number come from

houses in the middle ring, and the smallest from the outer. But had the above ratio been maintained, this must obviously have been purely accidental, for the number of cases examined (162) is a tiny fraction of the total case incidence; and here too other factors come into play, the one most likely to disturb the ratio being the fact that the largest of the shops visited happen to be situated in the middle ring, and the tendency there is in regard to all factories for the majority of workers to be drawn from streets and neighbourhoods as near to their work-place as possible.

TABLE VII.

CENTRAL WARDS.

| *Name of Ward.* | *Number of Cases.* | *Males.* | *Females.* |
|---|---|---|---|
| St. Paul | 4 | 3 | 1 |
| St. Mary | 5 | 0 | 5 |
| Dudderton and Nechells | 17 | 10 | 7 |
| St. Bartholomew | 5 | 4 | 1 |
| St. Martin and Deritend | 1 | 1 | 0 |
| Market Hall | 0 | 0 | 0 |
| Ladywood | 7 | 5 | 2 |
| Totals | 39 | 23 | 16 |

MIDDLE RING.

| *Name of Ward.* | *Number of Cases.* | *Males.* | *Females.* |
|---|---|---|---|
| Lozells | 5 | 3 | 2 |
| Aston | 14 | 4 | 10 |
| Washwood Heath | 1 | 0 | 1 |
| Saltley | 11 | 4 | 7 |
| Small Heath | 28 | 21 | 7 |
| Sparkbrook | 9 | 6 | 3 |
| Balsall Heath | 4 | 2 | 2 |
| Edgbaston | 2 | 0 | 2 |
| Rotton Park | 3 | 2 | 1 |
| All Saints | 17 | 14 | 3 |
| Totals | 94 | 56 | 38 |

OUTER RING.

| *Name of Ward.* | *Number of Cases.* | *Males.* | *Females.* |
|---|---|---|---|
| Soho | 0 | 0 | 0 |
| Sandwell | 0 | 0 | 0 |
| Handsworth | 1 | 1 | 0 |
| Erdington, N. | 0 | 0 | 0 |
| Erdington, S. | 0 | 0 | 0 |
| Yardley (and Haymills) | 9 | 9 | 0 |
| Acock's Green | 2 | 0 | 2 |
| Sparkhill | 0 | 0 | 0 |
| Moseley and King's Heath | 1 | 1 | 0 |
| Selly Oak (and Bourneville) | 5 | 3 | 2 |
| King's Norton (and Stirchley) | 3 | 1 | 2 |
| Northfield | 2 | 1 | 1 |
| Harborne | 2 | 2 | 0 |
| (Greet) | 4 | 4 | 0 |
| Totals | 29 | 22 | 7 |

The industrial occupation of women during the war has been suggested as a cause of the rise in the incidence and death-rate from phthisis for females at certain ages which has occurred in England and Wales. Many more figures will be necessary before this problem can be satisfactorily solved, but industrialization would certainly seem to be by far the most striking and far-reaching change in the conditions of daily life affecting large numbers of women at the ages concerned which the war has brought about, and the one best worth following up. The issue, however, is not quite a straight one, for although a rise appears when all England and Wales are taken together, and in some cities the rise has been considerable, yet other important areas have shown none, or perhaps one should rather say have as yet shown none.

Birmingham is such a place. Prior to and up to the time of this investigation (November–December, 1917) the steady decrease which had been going on for some years in incidence and mortality rate, both for women and men at industrial ages, continued to be maintained. The last published report is for the year 1916, but interim quarterly returns were available up to the end of 1917. More recently still, however, industrial case returns (Notifications) for about the first three-quarters (8½ months actually) of the present year (1918) are to hand, the total of which is already higher than that for 1917 complete. These returns also show for the factories investigated herein an increased case incidence in 50 per cent. of the A. factories, and in 54·5 per cent. of B. factories; and this with three and a half months of the year still to run—months, too, in which case incidence is likely to be high. May it be then, it is fair to ask, that here also industrialization, or at least some influence affecting case incidence, will now begin to show itself?

Another view is possible in a place like Birmingham, which should not be omitted. Housing conditions among the working classes, and particularly in certain districts, are admittedly bad. But factory conditions in the largest establishments, which give occupation to by far the greater numbers of munition workers, have been shown to be highly satisfactory. Not only so, but the health and welfare, as well as the feeding of immense numbers of these very people have been studied as never before, and during the entire period of their industrial occupation. To the question whether from the point of view of general health or risks of tubercular infection, it is preferable to spend eight hours of the day at work under such conditions as A. factories supply, or in a four-roomed back-to-back house in a Birmingham court, there can be but one answer.

The chief observations made in this inquiry may now be very briefly summarized.

1. The works seen were of two types:

A. Large and modern ones, providing satisfactory hygienic conditions.

B. Smaller, of antiquated construction, and abounding in defects.

2. Relative crowding of workers everywhere. The effect of this is worse in the smaller places, on account of restricted fresh air and light, &c.

3. Ventilation thoroughly bad in B. shops—not always satisfactorily solved in the best type. Windows not nearly enough made use of, and control of both heating and ventilation apt to be left in the wrong hands.

4. No evidence found of spreading of tuberculosis by *direct* contagion, neither by tools, materials, nor by any 'trade habit'.

5. Entire absence of visible signs of spitting in places where usually seen in works—but

6. Habit known as 'spitting in the suds' said to be prevalent. This should be investigated and stopped.

7. Home housing conditions very unsatisfactory in many parts of town. Everything points to the home as being the place of actual infection, either through contacts, or immanent in the house itself.

## General Summary of Conclusions.

1. The incidence of pulmonary tuberculosis upon particular occupations is greater than can be accounted for by the hypothesis that persons employed in such trades are *ab initio* of inferior physique and with a low general resistance to disease-producing causes.

2. The general statistics of employed women are insufficient to furnish a ground for exact reasoning as to variations of liability to contract tuberculosis.

3. The incidence of tuberculosis upon the inhabitants of towns is greater than can be accounted for by the general lowering of health associated with the home environment of the urban poor, and is consistent with the view that industrial employment introduces a special factor which makes for the development of tuberculosis.

4. The ratio of phthisis deaths to deaths from other causes in age groups is substantially correlated with the age death-rate from phthisis, and a tolerably exact impression of the level of phthisis mortality in a group of districts can be derived from the proportionate mortality index. In individual districts, however, the divergence may be considerable between the observed death-rate and that predicted from a knowledge of the proportionate mortality.

5. In the majority of English registration districts the proportionate phthisis mortality at ages 15–45 has increased since the outbreak of war.

6. The position of the maximum in the curve of proportionate mortality (women) is different, and has varied in a different way since the war, in towns of different kinds. This is manifested in the nearly uniform increase of the proportionate mortality (phthisis) at ages 15–20 in the great industrial towns, another result tending to suggest that the war-time increase of phthisis mortality is due to industrialization.

7. A field investigation in the Birmingham area discloses evidence (*a*) of a relatively greater incidence of phthisis upon the employees in hygienically unsuitable factories, (*b*) of a serious condition of overcrowding in industrial dwellings, but (*c*) no evidence of any specific trade habit amongst munition workers specially apt to favour the conveyance of phthisis from person to person.